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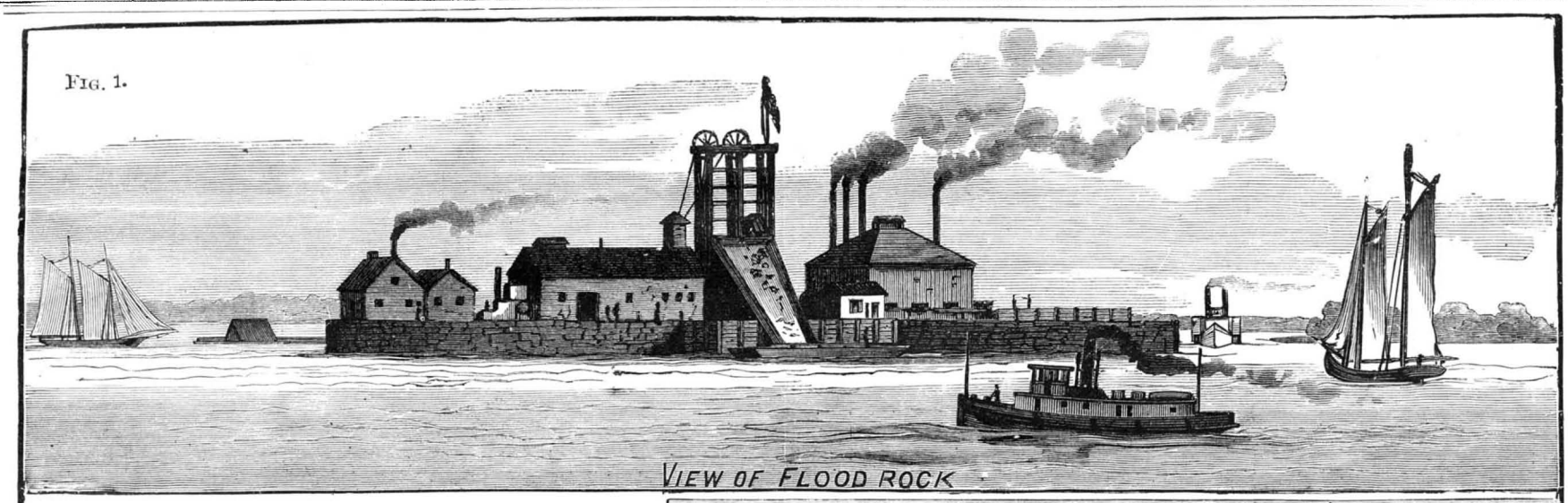
FIG. 1.



VIEW OF FLOOD ROCK

Fig. 2.—FORMER APPEARANCE OF FLOOD ROCK.

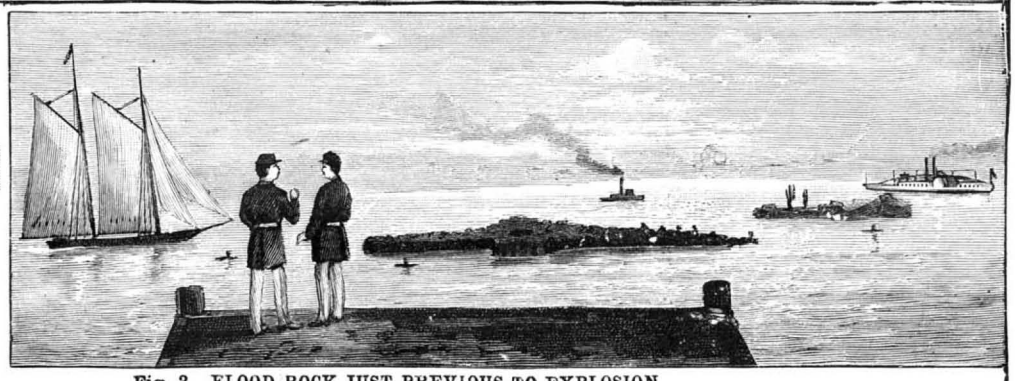


Fig. 3. FLOOD ROCK JUST PREVIOUS TO EXPLOSION.

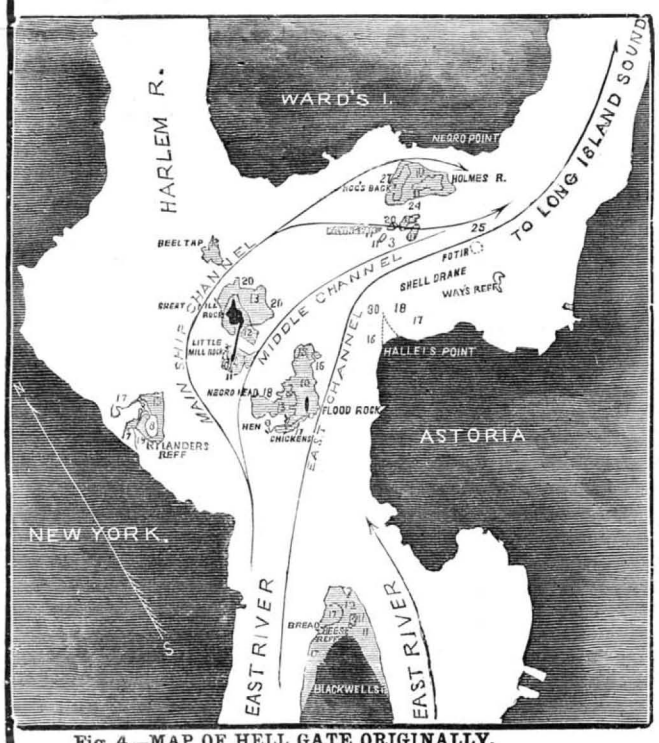


Fig. 4.—MAP OF HELL GATE ORIGINALLY.

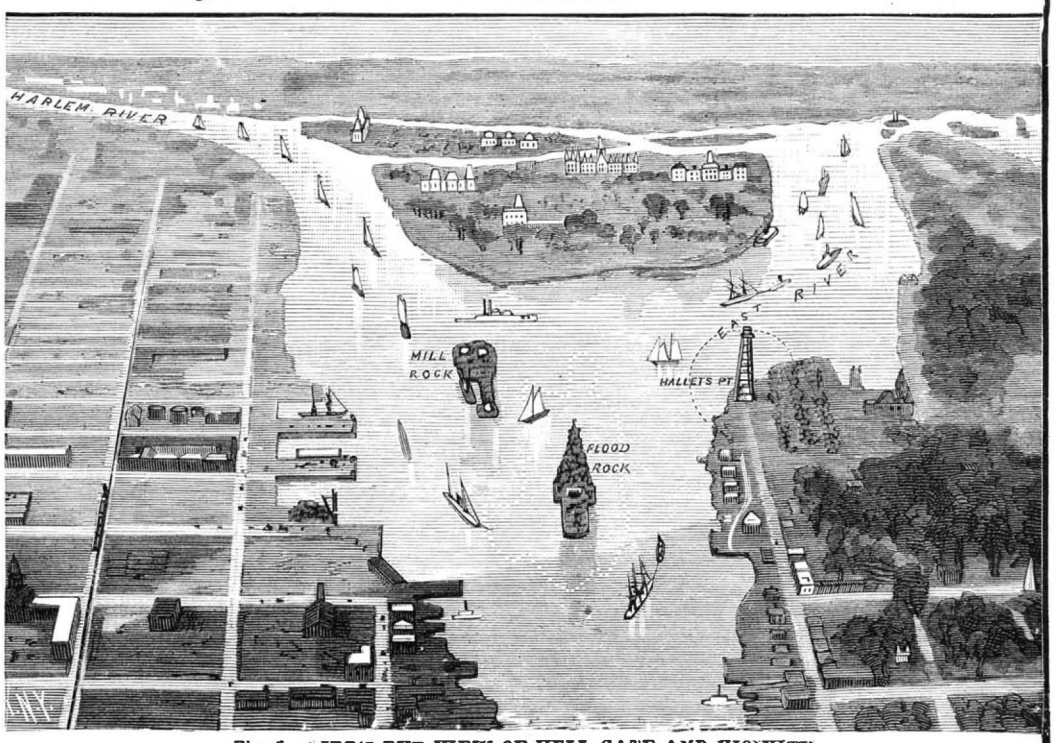
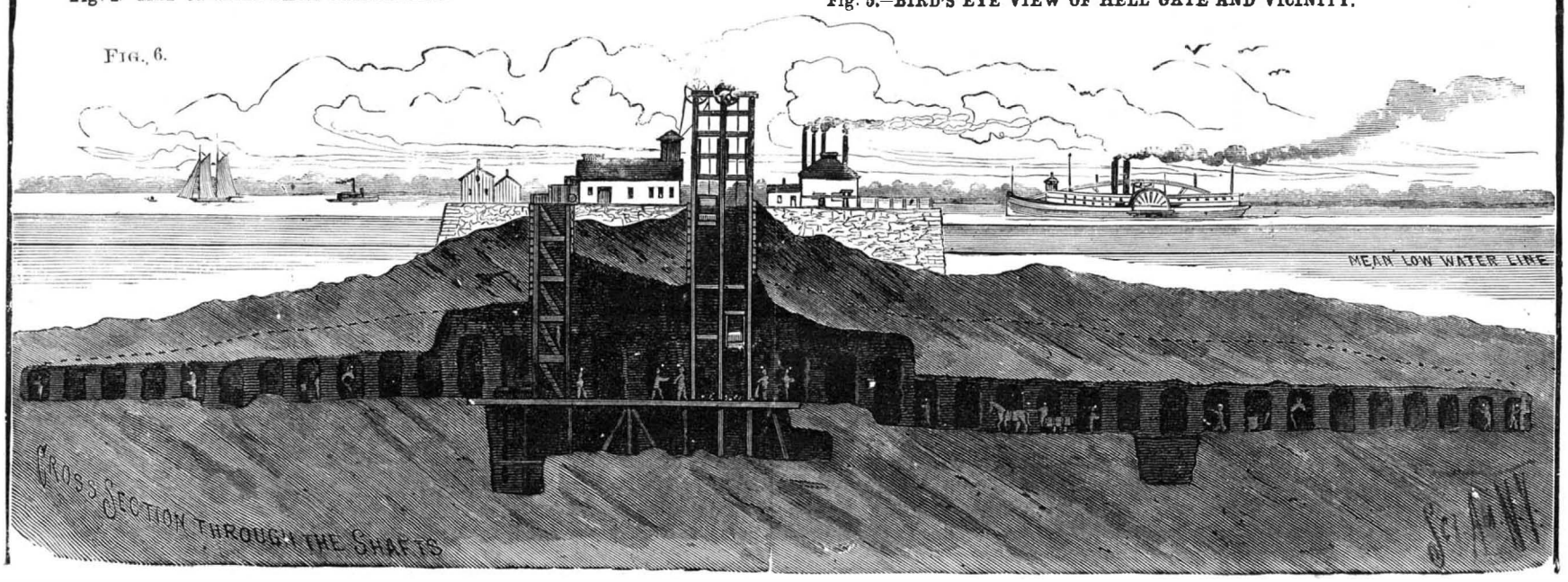


Fig. 5.—BIRD'S EYE VIEW OF HELL GATE AND VICINITY.

FIG. 6.



BLOWING UP FLOOD ROCK, HELL GATE.—[See page 227.]

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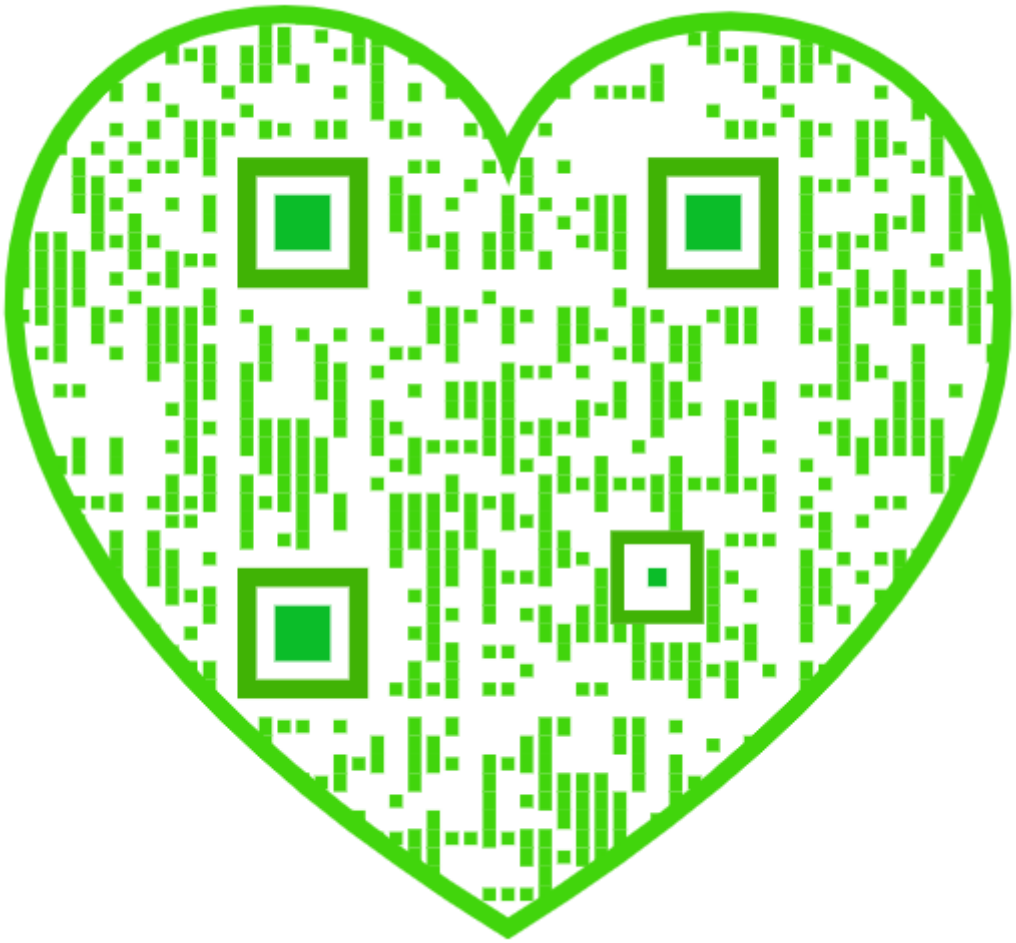

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NEW YORK, SATURDAY, OCTOBER 10, 1885.

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THE PENNSYLVANIA AEROLITE.

The people of Southwestern Pennsylvania were startled on the 26th of September, by the occurrence of a very unusual phenomenon; an immense aerolite had descended upon them. At first the impression prevailed that the district had been visited by an earthquake or that a terrible explosion of natural gas had taken place, while others decided that a pretty large set of boilers had burst, or that a gigantic blast had thrown down a large mass of rock from some neighboring quarry. Loud detonations were heard throughout that entire section, the explosions apparently following a straight line across the country, and causing not a little consternation among the people.

The meteor seems to have passed from the northeast to the southwest, and the noise of its passage, which was variously described as resembling the rattling of heavy artillery over a solid roadbed or as a mighty peal of thunder, was heard over a large area of country in the neighborhood of Pittsburg and to the south. A number of witnesses describe it as an immense mass of fire, fully as large as the largest barns—and Pennsylvania barns, it will be remembered, are noted for their size. A powerful flame of deep red color, which tapered off into a darker tail, seemed attached to the mass. This, however, is stated to have disappeared as the meteor came nearer, and the color of the mass changed to a bluish white, which was maintained as long as it remained in sight.

A mail carrier on horseback and a farmer who was plowing at the time both describe their animals as being so terrified that they remained perfectly motionless, and could not be persuaded to stir for several minutes after the fiery visitor had disappeared. It finally struck the earth on the farm of Mr. Buckland, in Jefferson Township, Washington County, near the West Virginia line. The stone broke into three pieces, and became partly buried. The color is gray, with streaks of red running over it; possibly from the formation of sesquioxide of iron. The form is irregular, and the dimensions, if correctly reported, are without precedent. It is stated to be from 30 to 50 feet in diameter, but we doubt very much that the statement can be verified. The Gibbs meteorite, in the Yale College Cabinet at New Haven, is noted for its size, but it weighs only 1,635 pounds, and has a length of 3 feet 4 inches, a breadth of 2 feet 4 inches, and a height of 1 foot 4 inches. It came from the Red River.

A still more noted one is the Tucson meteorite, from Sonora, Mexico, which is now at the Smithsonian Institution. It is ring-shaped, and 49 inches in its greatest diameter. The most remarkable masses of which we have any knowledge have been found in South America. One discovered in the district of Chaco-Gualamba was estimated to weigh 16 tons, and another found near Bahia, Brazil, to contain 28 cubic feet, and to weigh 7 tons. These weights and volumes would, however, be quite dwarfed by a comparison with those reported for the Pennsylvania meteorite. But there is probably still a little romance attached to these accounts, and the true dimensions will not be reached until later.

An odd superstition clings to meteors, and many who witnessed this remarkable one were inspired with the dread belief that it brought with it a spirit of pestilence and famine; but if these people would only call to remembrance the wide prevalence of meteoric visitors, they would conclude that the most persistent spirit which their imagination could attach to them must be quite exhausted by this time. Dr. Kleiber of St. Petersburg has calculated that 4,950 pounds of meteoric dust fall to the earth every hour, which would make 59 tons a day, or more than 21,500 tons in a year, while Professor Proctor thinks that even this estimate is too small. Yet very little damage is done by the fall of these "air stones," for the most of them fall upon unoccupied ground or into the sea. Relic hunters are reported to be already at work and carrying off the meteorite by piecemeal. This seems to indicate either that the mass was very much shattered by its fall, or that it has a large predominance of stony matter, which would enable fragments to be broken off; for the most accomplished vandal would find difficulty in securing a souvenir from a piece of meteoric iron.

GRAPHICAL COMPARISON OF PERFORATION FORMULÆ.

In connection with the Board on Armament of Fortifications, Major W. R. King, of the Corps of Engineers, U. S. Army, has compiled a comparative table of all formulæ relating to the perforation of armor plating; and in order to show at a glance the relative values obtained by using the different formulæ, has plotted the results to a uniform scale. As this sheet gives information of some interest to engineers, it has been published by the government and distributed to the different members of the corps. The two axes in the diagram represent the thickness of the unbacked wrought iron plating in inches, and the energy in foot tons per inch of shot's circumference, so that the resulting curves at any point show the values obtained from the formulæ of different authorities.

They display wide discrepancies, and, indeed, the variations in the quality of both the shot and the plate used by the investigators are such that it is quite impossible to obtain any general formulæ which are entirely accurate. The present graphical method has the advantage, however, of showing these conflicting results with admirable clearness, and it may be valuable in helping us to reach more uniform formulæ by calling attention to the existing confusion, and the need for further and more careful experimentation.

CURIOUS FEATURES OF THE ELECTRIC LIGHTING BUSINESS.

The business of the voltaic arc light companies may be said to furnish additional evidence of the credulity of human nature. The picture presented by hundreds of sub-companies spread over the country, living on prospects rather than profits, stimulates the observer and invites the analyst. At the recent meeting of the National Electric Light Association, it was not difficult to see in which direction the profit lay. Those engaged in selling light exhibited the unmistakable evidences of depression, while their fellows who confine their efforts to the sale of electric lighting plant were correspondingly elated and buoyant.

The first discussed economical processes with an interest that was profound and serious, as though their only hope of profit lay in a reduction of running expenses, while the second looked on with ill-concealed indifference.

To those who have had the time and inclination to study the electric lighting business, this will not be surprising. They will have discovered that there is an immense profit in electric lighting plant, and but little, if any at all, in the sale of the light. Like glucose, the electric lighting plant business is advertised but little; the private circular having been found to be the most judicious method of reaching purchasers.

Go into the office of one of the so-called parent companies, and talk about electric lighting plant, and you will be astonished by the prospective profits of light selling. It will be proved to you with mathematical precision that few modern enterprises offer such a large margin of profit as the operation of an electric lighting plant. But if there is so much profit in selling the light, why don't these companies go into the business themselves? Why do they confine themselves to selling plant? You will scarcely fail to be struck with this when hearing the plant people talk on the subject of light selling.

Last week two large electric lighting plant companies were consolidated. One of these companies only two years ago had a little office in Union Square, before which a single arc light hung suspended. This was rarely lighted, as if the dispensing of arc light was a luxury far too costly to be indulged in by any but sub-companies.

This company has now a great factory in New York city, where large quantities of lighting plant are manufactured for those provincial projectors who are possessed of robust bank accounts and adamantine credulity.

Fortunes have been made in arc light apparatus, but the only people who have profited, thus far, from the light itself are the gas companies, because its brilliancy so pales the gas jets by comparison that gas consumers, in order to counteract its influences, are forced to turn on more burners and use more gas.

STUDENT MECHANICS.

The most ardent supporters of technical schools do not claim that they can supersede the workshop; but they do claim, properly, that the inexperienced boy can obtain in them a general knowledge of the character of materials, the methods of working them and the reasons why these methods differ. None of our older mechanics ever regret the smattering of theoretical knowledge of natural laws that they obtained at school from the meager instruction afforded by the text book on natural philosophy; and in after years some of its statements—mere commonly known axioms—have been easy to quote, and beneficial to heed. Book knowledge on practical subjects may be useful, even if it does not teach the handling of tools and the best methods of doing a job. As a preliminary to the shop novitiate, the technical school is a wonderful helper.

Sometimes boys of fourteen or fifteen see clearer than do their elders the possible advantages of a theoretical mechanical education; but no experienced mechanic can visit one of our modern technical schools without feeling that he was a loser because they were not in his boyhood days, and that he had no opportunity for the advantages which they unquestionably give to the embryo mechanic. Such a school is a means of guiding the young man to the choice of an occupation; mechanical bent, discouraged at home, is given room for development. Occasionally, however, a parent has the wisdom to help the son in his inclination.

An instance in illustration is that of a boy of fourteen, left by his father, a prominent government official, with a considerable fortune. He shows a decided taste for mechanics, is provided by his sensible mother with a home workshop used in vacations will leave

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his grammar school for a technical school at the expiration of his course, and will be graduated from thence—if events are fortunate—to a workshop; so, instead of going into a "genteel" profession, he will become a useful mechanic.

A college professor in an Eastern State "releases his mind" by employing himself in a workshop in his attic. He has placed many articles of elegant and useful furniture in his house, which are the work of his own hands, and are admired by all who visit at his house. By the connivance of his wife, broken chairs, leaky tinware, dilapidated toys, and similar articles are gathered from the neighborhood to delight the sedate and learned professor, who revamps them as an amusement. He said in conversation, a short time ago, that if the technical school had existed in his callow days, he would have been at the head of a mechanical shop instead of a professor in a college, and he thought he might have been a more contented man.

A NEW STAR WITHIN A STAR CLOUD.

BY RICHARD A. PROCTOR.

A star has given an answer to the theory, complacently repeated long after it has been disproved, that the nebulæ or star clouds are external galaxies. The entire aspect of the star-strewn heavens may in a sense be said to be altered by the appearance of a star—though it be but of the eighth magnitude—in the heart of the great nebula in Andromeda. At once we see that all the varied glories of the star depths, giant suns and suns like our own, isolated suns, and groupings of minor suns, all forms and orders of star clouds, are as certainly part of the glory of our own galaxy as all the varied orders of planets are of the realm over which our sun bears sway. Stars have appeared ere now in the midst of nebulous masses; but these masses have in every case of the kind, thus far, been gaseous. The Andromeda nebula, whatever be its actual constitution, is not a great mass of luminous gas. It is not one of those nebulæ that like the great "fish mouth nebula in Orion," the still vaster "keyhole nebula in Argo," or the "lover's knot nebula in Dorado," have given evidence, under spectroscopic scrutiny, of being great self-luminous masses of hydrogen, nitrogen, and some other as yet undetermined gas. Instead of the three or four bright lines into which the light of the gaseous nebulæ is resolved by the spectroscope, the light of the nebulæ in Andromeda gives a spectrum like that of a star or of our own sun—a rainbow-colored streak crossed by dark lines, and only differing from the spectrum of a star in showing rather stronger absorption near the red end than is usual in stellar spectra.

In the midst of this great mass of stellar material, how distributed we know not, a new star has suddenly made its appearance. I was about to say that this new star came into existence but a few days ago. But who shall say how old the news really is that the light rays from the Andromeda nebula have recently brought us? From even the nearest star, light takes 3½ years to reach us, from Sirius 20 years at least, and from the great majority of the stars that deck our skies, hundreds of years. It may well be that the outburst, or whatever other change it was, which has made the new star visible to us occurred a thousand years ago; for assuredly the greater number of the stars which shine no more brightly than this new one does (stars which the keenest human vision cannot see) lie at distances which light could not traverse in less than a thousand years. It is as thus viewed perhaps that the study of the great nebula in Andromeda acquires chief interest; the nebula lies at so immense a distance that it must be inconceivably large. Putting it no farther away than the nearest star—and probably it is many times farther away—its volume must exceed many thousands of times the whole domain of the sun. If the orbit of the distant Neptune encircled like a belt a gigantic sphere, whose whole surface shone with the same intrinsic luster as our sun's, that monstrous orb, removed to the distance of the Andromeda nebula, would look no larger (though of course it would look far brighter) than the nuclear heart of that star cloud. The nebula must have a volume measurable only by billions of trillions of cubic miles of space. Be it remembered that this estimate of the extent of the region occupied by this wonderful nebula is far short of that which had to be adopted by those who accepted the usual account of the nebula. For, according to that account, the nebula in Andromeda does not lie within the galaxy at all, but thousands of times farther away than the remotest parts of our stellar system. It is in fact, or rather was, according to that account, a galaxy itself, reduced by vastness of distance to the appearance of a mere faint fleck of misty light on the dark vault of heaven—a fleck barely to be seen by the unaided eye.

Hereafter, of course, the great Andromeda nebula can no longer be so regarded. The change involved by the appearance of the new star in the midst of a nebula which under the most powerful telescopic scrutiny had shown no trace of a star, would be too stupendous to be regarded as possible, or even conceivable. We can imagine that when a new star shone suddenly forth in the Northern Crown in 1866, astronomers in some remote part of our own galaxy might have recognized the new star, as we did, who are near the middle of the galaxy; we may even conceive that astronomers living in some outlying galaxy, if armed with telescopes to show individually all the thousands of millions of stars in our stellar system, might have noted that new star as one added to those countless millions. That would be supposing such astronomers much keener sighted, and much readier at counting multitudinous points, than any astronomers who have yet appeared on this earth. But that would not in the slightest degree resemble what our astronomers have recognized in the Andromeda nebula. There they have seen a star, visible with very small telescopes (Argelander's 2½ inch telescope showed stars down to the tenth magnitude), making sudden appearance in the heart of a star cloud which had been scrutinized with the most powerful telescopes yet made by man, without any trace of a star being discovered in it. It is as though in the heart of our galaxy there should suddenly appear a star outshining all the other stars hundreds of thousands of times.

We are compelled, then, to assume that no such change as this has taken place. What has happened has manifestly been simply that, in a star cloud forming part of our own galaxy, a change has taken place by which a star, probably no larger than those minor suns which form the wealth of the Milky Way, has made its appearance. Possibly the star will be found to last but for a short time, like the one which shone out in the Northern Crown as a second magnitude star, and that other which but a few years ago blazed suddenly forth in the Swan—to fade out again, not like the former into a faint star such as it had before been, but into a bluish globe of gaseous matter, in fact, into what is called a planetary nebula.

One conclusion which has been drawn from the appearance of the new star in the midst of the Andromeda nebula, I venture to regard as entirely erroneous. It has been said that the phenomenon confirms, if it does not establish, Laplace's theory of the origin of our solar system from a great mass of rotating gas. If any occurrence in the star depths could possibly shake men's faith in that theory—or rather speculation, for so Laplace regarded it—the sudden appearance of a new star in the midst of a mass of stellar matter should do so. A theory which has been accepted by astronomers under the mistaken idea that there are no physical objections against it, and by physicists under the equally mistaken idea that observed astronomical facts absolutely require it; a hypothesis according to which a mass of gas, far rarer than hydrogen at atmospheric pressure (nay, almost infinitely rarer), and having a span of about six thousand millions of miles, rotated for millions of years as a coherent whole—such a theory may be expected to retain vitality under almost any conceivable shock. Otherwise, assuredly the discovery that sudden and rapid changes, not the inconceivably slow changes imagined by Laplace, affect star clouds, of enormous size, might be expected to destroy men's faith in an idea which its celebrated author never regarded as more than a guess, and which with the knowledge of physical laws possessed in our time should have been long since rejected as obviously erroneous. Whatever light the further telescopic study and the spectroscopic study (yet to be begun) of the new star and of the changing nebula may bring, I venture to express confident assurance that the nebular hypothesis of Laplace will not be confirmed. If the change in the Andromeda nebula throws any light at all on processes of evolution, it will rather be on those by which the galaxy reached its present condition than on those belonging to the past of our solar system. We are beginning to recognize in the architecture of the galaxy evidence of processes by which regions of space incomparably vaster than the whole domain of the sun are affected, or have been affected in the past, under the action of forces which seem to have a different character from any whose operation we can follow within the solar system. We see that isolated suns have been drawn to one region, streams and aggregations of minor stars in other directions, and the nebulæ elsewhere again; precisely as, within the solar system, we have the giant planets, the terrestrial planets, the asteroids, the systems of satellites, and so forth, each occupying their appropriate domain. It may well be that in the study of local changes still going on, some light may be thrown on long past processes by which the stellar groupings attained their present form.

Suit about a Chimney.

A dispute has arisen between the Bridgeport, Conn., Water Company and the Bridgeport Paper Company regarding the ownership of a chimney which both have jointly used for many years. The paper company wish to pull down the chimney and build a larger one, and on Sunday they began to pull it down, but were restrained by an injunction signed by Judge Granger, of the Superior Court. The water company claim that they cannot do without a chimney, even for a single day, as more than 40,000 people depend upon the company for a supply of water.

Foreign Roads.

France has some 19,000 miles of railroads. The scientific spirit of this nation, says a London paper, is shown by the fact that their trains pass to the left of each other, and not to the right. We go to the right in our wagons and trains, probably from having confounded the moral meaning of the right with the physical right hand. We say, do right, and therefore we go right, whereas we would do right if we went left. You drive your horse sitting on the right of him, and therefore the man who has to pass you on the right is partly hidden from you by your horse's head. If you sat on the left you would see the man on your right, and if he sat on the side nearest to instead of furthest from you, he would not have half the trouble he now has. The French, therefore, is the left-eyed nation. Passengers get out of the trains on the left hand side. The government taxes every ticket sold by a railroad since the late war. The trains are classified, and only high class passengers—those who pay the highest fares—go on the fastest trains. We have copied from the French our late system of shutting the passengers up in the station until the train is ready, and they can go through the gate and show their tickets. French travelers are allowed only two-thirds of 100 pounds of baggage free; those who are going outside of France are allowed only 55 pounds. The railroad charges for entering the baggage or booking it. We have already adopted the French plan of collections on packages left at the station, but the French only charge one penny, while we charge two. All the railroads in France are run on Paris time.

About Fig Trees.

"Will fig trees that are planted out in the garden bear better than those that are grown in boxes, and wintered in the cellar? How deep should they be planted? And in burying for winter, should they be first covered with straw, or with earth only?"

Wm. Falconer answers the above query in respect to the culture of this delicious fruit in the *American Garden* as follows:

Fig trees planted out bear better than those in boxes, and with far less trouble. You are more certain of a crop from young plants that are grown in tubs or boxes that you would be from the same sized or aged plants that are planted out, but the out-door plants can become large bushes, hence have more fig-bearing wood than box-grown ones. All the care the out-door fig trees need is to bend them down and peg them flat to the ground, and bury them about a foot deep with earth in the fall, and unearth them again in spring. My neighbor, Mr. Barlow, on Long Island, gets enormous crops off his fig trees treated in this way.

When planting fig trees, plant as you would any other bush or shrub; shake the earth from the roots and spread them out. There is nothing delicate about the rooting of a fig tree. It roots easily.

In burying for winter, use earth only. Straw or litter would be cozy winter quarters for field mice, and peeling the fig trees capital amusement for the mischievous rodents.

Duty of Coal.

Notwithstanding the well-known imperfections in all appliances for utilizing the full amount of energy which is due to the combustion of coal, both on land and water, the great improvements in that direction which have been made during the last quarter of a century are indeed remarkable. A single example, for instance, is afforded in the case of the steamer Burgos, built especially to carry cargoes cheaply at a low speed, and which left England for China with a cargo weighing 5,600,000 pounds. During the first part of the voyage, from Plymouth to Alexandria, the consumption of coal was 282,240 pounds, the distance being 3,380 miles; the consumption per mile was, therefore, only 83·5 pounds, and the consumption per ton of cargo per mile, 0·028 pound; in other words, half an ounce of coal propelled one ton of cargo per mile. It is further stated that the best locomotive performance in this country shows a consumption of about two ounces of coal per ton of freight hauled one mile, at the rate of 13 miles an hour, including stoppages; on lines having grades of from 53 to 70 feet per mile, the consumption often rises to five or more ounces.—*N. Y. Sun.*

Manufacture of Aluminum by Electrolysis.

La Lumiere Electrique says that Mr. L. Senet has devised a new process that permits of obtaining aluminum, as well as copper, silver, etc., by electrolytic way. A current of from 6 to 7 volts and 4 amperes is made to act upon a saturated solution of sulphate of aluminum in the presence of a solution of chloride of sodium, the two solutions being separated by a porous vessel. There forms a double chloride of aluminum and sodium, which is decomposed; and the aluminum that is set free deposits upon the negative electrode.

The process may be applied either for obtaining deposits of aluminum upon any objects whatever, or, what is more important, for the cheap manufacture of the metal.

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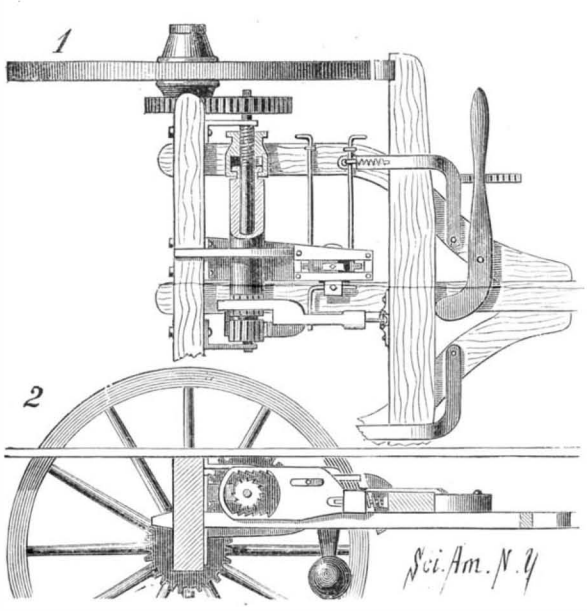
AN AUTOMATIC WAGON BRAKE.

Fig. 1 is a plan view, and Fig. 2 is a vertical section of an automatic wagon brake invented by Messrs. Minor Cartmell and Nelson Bayless, of Urbana, Ohio. Attached to the hub of one hind wheel is a gear wheel, which engages in front of it with a wheel on a tapering shaft carrying a barrel correspondingly tapered to fit snugly on the shaft. On the opposite end of the shaft is a ratchet wheel, and on the like end of the barrel is another ratchet wheel; the teeth of these wheels run in opposite directions to one another. The frictional hold of the barrel on the shaft is regulated by means of a nut. A slotted drawbar having reversely arranged ratchet teeth on its upper and lower jaws is arranged to engage with the ratchet wheels on opposite sides of the shaft and barrel. The brake beam is connected with the drawbar by an adjustable coupling pin. When the wagon is on a level, the teeth on the upper and lower jaws of the drawbar do not engage with either of the ratchet wheels; and the drawbar is held in such position by a weighted pendulum.

When the wagon is traveling forward, the shaft has a backward rotation; and when the wagon strikes a down grade of sufficient declivity, the pendulum swings forward and a crank on the shaft to which the pendulum rod is attached drops the drawbar into engagement with the ratchet on the barrel, which draws the brake beam with its shoes against the wagon wheels. When the wagon passes to a level, the pendulum swings back to an extent that, by the aid of the crank, disengages the upper jaw of the drawbar from the ratchet on the barrel, but not sufficiently to engage the lower jaw with the ratchet on the shaft. Suitable springs act upon the brake beam to remove its shoes from the wheels. When the wagon strikes an up grade, the pendulum swings back far enough to cause the crank to raise the drawbar, so that the teeth on its lower jaw mesh with the ratchet on the shaft; but, owing to the direction of motion of this ratchet and the arrangement of its teeth, the ratchet will slip over the teeth on the jaw, and fail to operate the drawbar until the wagon stops and makes a slight backward movement, when the shaft, revolving forward, draws the brake against the wheels. The forward motion of the wagon again releases the wheels. By adjusting two cut-offs which limit the swing of the pendulum, the wagon can be backed on either an up or a down grade. When the wagon is passing over light grades, or when the roads are heavy, the mechanism can be adjusted so that the brake will not act. A hand lever is provided for locking the wagon when on a level, should the driver desire to leave his team untied. This wagon brake accomplishes all the work required of such a device, and in its control of back action is of much value on long grades when applied to heavily loaded wagons, as the driver can rest his team whenever necessary. As the brake is carried by the running gear, its working is not interfered with by the removal of the wagon box. The brake is simple, and can be strongly and durably built.



CARTMELL & BAYLESS' AUTOMATIC WAGON BRAKE.

Spontaneous Combustion from Coal Dust.

The conclusion has been reached by M. Fayol that the absorption of atmospheric oxygen by coal dust usually produces the rise in temperature to which spontaneous combustion is due. He finds that lignite is ignited at the low temperature of 300 deg., anthracite at 575 deg., and other varieties of coal, in powdered form, at intermediate temperatures.

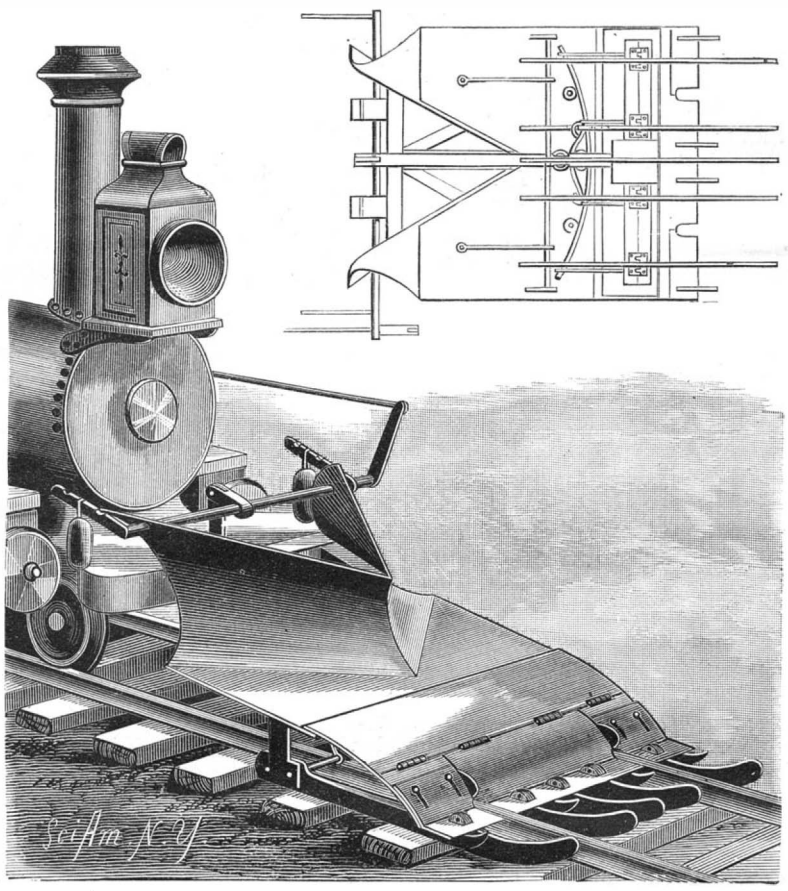
AN IMPROVED SNOW PLOW.

The engraving represents a snow plow adapted especially for use in clearing railway tracks, although it may also be used for clearing paths over common roads. The plow is made with concave mould boards, joined at their forward ends and diverging backward, and secured to a platform which inclines downward and forward, and has a square end; these parts are supported by a frame of wood or iron bars connecting the plow to the front of a locomotive, or the front of a traction engine or wheeled vehicle when common roads are to be cleared. The rear part of the shovel plate is bolted rigidly to a bar of a frame supported by the bed plate, so that its rear end overlaps the forward end of the bed plate; and the front shovel plate —preferably made in three sections in a railway snow plow—is hinged to the forward edge of the rear plate, and rests upon the front bar of the frame. To a series of arms projecting backward from the rear bar of the frame is fixed a curved bar (shown in the inverted view of the plow), which bears against guide and anti-friction rollers. With this construction the shovel plates and frame are supported by the bed plate, and are at liberty to turn bodily to either side as the curved bar moves over the rollers, to allow the machine to turn curves more readily without damage to the plow runners. The forward ends of the runners are pivotally connected to the front edge of the forward shovel plate by pins; the rear ends of the runners have slots through which passes a rod held at both ends in hangers fixed to the bed plate. One or more of the central runners have their slots open at the back ends; this allows these runners to be removed, as may sometimes be necessary when the ballast is high at the center of the track.

To the outer edge of the forward shovel plate, at points between the runners, are fixed upwardly curved guard bars, which serve to lift the shovels above any obstacles that may chance to lie in the path of the plow between the runners, and that would not be struck by the runners. The rails enter slots made in the shovel plate. The forward shovel plate is made in three separate sections, to allow of independent movement as the various runners meet inequalities of ground or tie surface along the road or track; and to allow the outside runners to be lifted higher at the forward ends than the inner runners, so as to meet and pass over considerable inequalities on the ends of the ties, and also to allow vertical adjustment of the end sections above the center one when it is desired not to cut down the snow quite so close to the ties at the outside of the rails. The end shovel sections are made with two plates held to each other by screws passing through slots. Fixed at the opposite ends of the central section are cutters which make a clean cut through the snow along the tops of the rails. When intended for use on common roads, the shovel plate may be made in one piece and without the rail slots and cutters.

A transversely ranging shaft journaled in the rear upper part of the mould board is so connected with the shovel plates and plow runners as to lift them when it is turned by means of a rod extending from a crank arm at one end of the engine cab. This shaft is also provided with arms carrying weights, which serve to counterbalance the weight of the shovels and runners. It will be seen that the mould board can be so made as to throw all the snow to either side of the track, or to divide it evenly, as represented in the engraving. All the parts of the plow are simple, and are so arranged as to facilitate repairing; the machine can be strongly and durably built.

This invention has been patented by Mr. Joseph Wackerman, of Warren, Pa.



WACKERMAN'S IMPROVED SNOW PLOW.

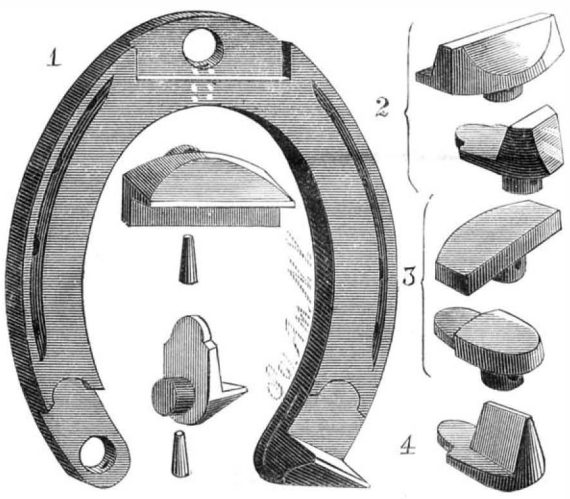
Loads on Roofs.

The load to which a roof is exposed is of two kinds: first, that due to the weight of the materials; and second, that due to the wind, or its vertical pressure. The first increases with the span, and must be estimated from tables of the weight of the materials used. In the second category the vertical component of the wind has to be considered, calculated about 40 lb. per square foot. For ordinary roofs the following data have been given per square foot: 5 lb. for weight of truss, 5 lb. for purlines, etc., 10 lb. for slate, and 36 lb. for wind, making a total pressure of 56 lb. or ½ cwt., about 1-40 ton per square foot. For very large roofs these figures ought to be increased, and we may usefully refer to the figures used for the St. Pancras station roof, as given by Mr. Barlow. Here the total estimated pressure, exclusive of the weight of truss, was taken at 80 lb. per foot, and this was made up as follows:

The truss, 10 lb. per square foot, covering 36 lb., wind 34 lb. The calculation of the strains can be obtained by analytical or graphical means, both of which methods are described in handbooks which treat of these matters. It is convenient to suppose this total load concentrated at certain points, such as the foot of rafter, the apex of roof, and a point midway between. Whatever the weight may be on each rafter, half of it will be discharged at each of the two extremities if we regard it as a rigid beam. But if we divide the length, the middle or purline point will receive double the share of weight discharged at the foot. There will, in fact, be equal weights at the apex and the purline point, but half only at the foot of rafter. In short, at the apex and purline point the loads are doubled, owing to the bearings of two adjacent lengths coming together. Thus, if we put five at the foot of rafter, we must put ten at the purline point and ten at the apex of roof.—*Building News.*

AN IMPROVED HORSESHOE.

In the horseshoe herewith illustrated, the calks are made detachable and interchangeable, the object being to simplify and strengthen the construction. The body of the shoe is made in any preferred form, and is provided with nail holes, so as to be attached in the ordinary manner. The toe calk fits in a recess formed in the under surface of the toe part of the shoe; a lug upon the inner side of the calk enters a hole made through the shoe. The calk is held firmly in place by a pin passing through a hole in the shoe (shown by the dotted lines in Fig. 1) and entering a hole in the lug. The heel calks are secured in a similar way; the shape of these calks and of the recesses they enter is clearly shown in the engraving. The small figures show calks of various shapes. It will be seen that by the use of these calks—which may be easily and rapidly changed to suit the weather—the horse may always be correctly shod. All wear comes upon the calks alone, thus requiring less frequent trips to the blacksmith shop. The facility with which the change from smooth to sharp, or sharp to smooth calks can be made not only saves time and expense, but also does away with the necessity of making new holes in the hoof each time the shoe is changed. This invention has been patented by Mr. A. L. Stevens; particulars can be had from Mr. J. W. Daskam, general agent, Stamford, Conn.



THE STEVENS PATENT HORSESHOE.

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BLOWING UP FLOOD ROCK, HELL GATE.

The many large and small rocks which originally filled the bend made by the East River in rounding Astoria, were so located as to make all the deep channels extremely tortuous; a great part of these rocks was below

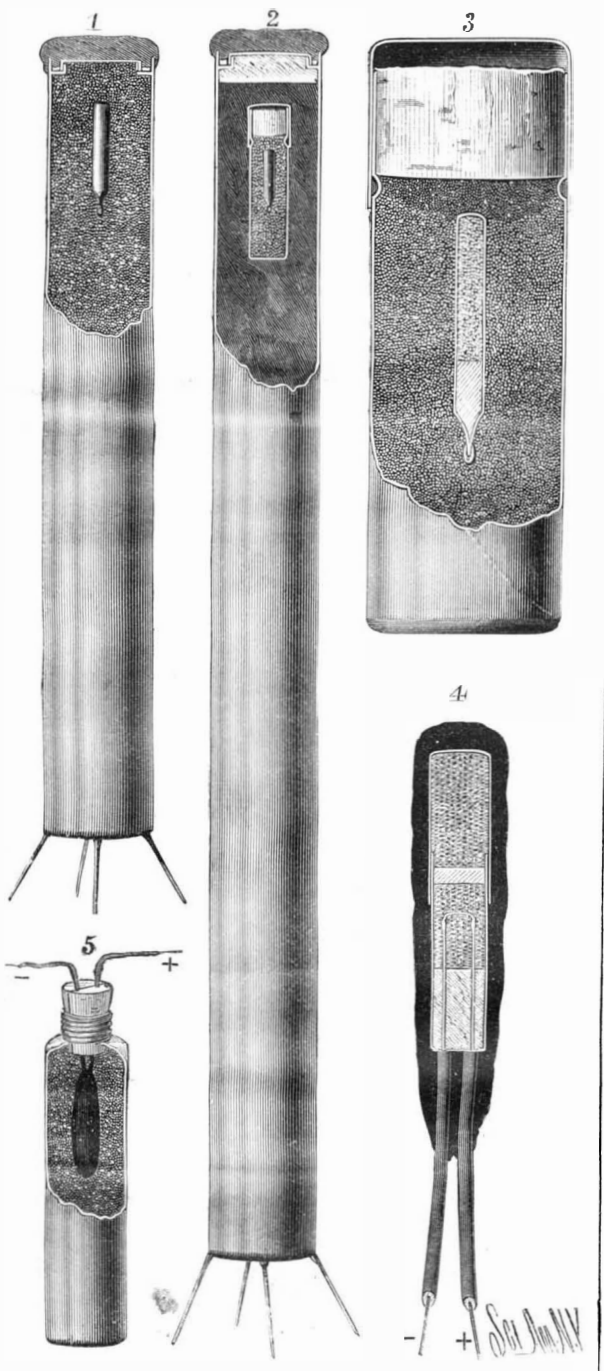

Fig. 7.—THE CARTRIDGES AND EXPLODERS.

the surface of the water even at low tide, and yet not sufficiently deep to be cleared by the keels of vessels; in addition, the current had a maximum velocity of 8½ miles an hour. These features combined to make the passage through Hell Gate extremely dangerous, as the boat had barely passed one obstruction before it met the next; and as there were many strong whirlpools, the prompt obedience of the vessel to the movements of her rudder was by no means assured. The magnitude of the obstacle thus placed in the path of all commerce between New York city and Long Island Sound can be imagined. Fig. 4 shows clearly the condition of Hell Gate about forty years ago, and gives the depth of water at various points, together with the three main courses.

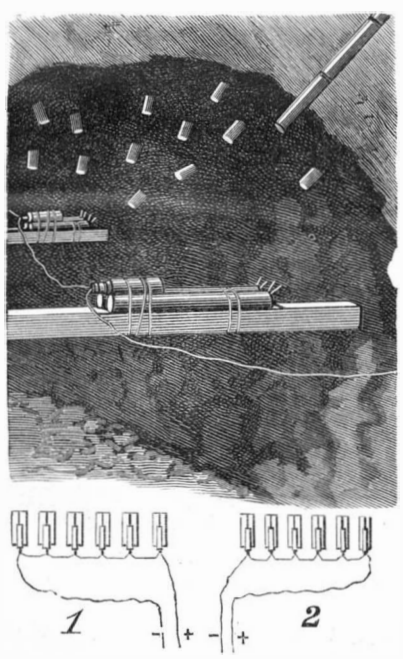

Fig. 9.—THE FUSES AND FIRING CARTRIDGES IN PLACE.

Naturally, attempts were early made to clear the passage, but they were all confined to the removal of the smaller obstructions.

Work upon Hallet's Point, which projected 325 ft. from Astoria shore, was begun in 1869, by the building of a heavy coffer dam of timber next to the shore. When this dam had been pumped out, a shaft was sunk to a depth of 33 feet, and from this ten radiating headings were started under the reef; these headings were united by numerous cross galleries. The total length of headings and galleries was 7,426 feet, and the roof was supported by 173 piers, each about 10 feet square. There were 47,461 cubic yards of rock removed by the excavation, and 3,676 drill holes, from 2 to 3 inches in diameter, were made in the roof and piers to an average depth of 9 feet. Into these holes was placed a charge of 47,781 pounds of dynamite; the separate charges were arranged in 184 battery groups of 20 charges each. The explosion took place September 24, 1876. This removed one of the most serious obstacles, since vessels coming to New York had no sooner rounded Hallet's Point than they were driven by the rapid current toward Flood Rock.

At the present time Diamond, Coenties, Way's Reef, Shelldrake, Heel Top, Frying Pan, Pot Rock, and Hallet's Point have been removed to a depth of 26 feet at mean low water; Bread and Cheese Reef has been inclosed, and a stone dike built from Great Mill to Little Mill Rock; in addition, many smaller rocks have been removed, and Flood Rock has been mined, charged with explosives, and only awaits the touch of a button to reduce it to a mass of small broken stone.

In the SCIENTIFIC AMERICAN of July 25, 1885, we described the method of mining and drilling Flood Rock; it is only necessary here to give a few points. The main shaft was sunk to a depth of 64 feet below mean low tide, and from the foot of this headings were extended parallel with and at right angles to the current; there are 24 of the former and 46 of the latter. The extreme length—parallel with the stream—is 1,200 feet, and the width 625. The roof of this chamber, which has an area of a little over 9 acres, averages about 15 feet in thickness, and is supported by 467 enormous piers. The total length of the galleries is 21,670 feet.

Into the roof and tops of the piers there have been drilled 13,286 holes, 3 inches in diameter and having an average depth of 9 feet; in other words, the rock has been pierced with holes having an aggregate length of over 22 miles. At the present writing these holes have been filled with rack-a-rock and dynamite, all the buildings and machinery have been removed from the small island, the electrical connections have been made, and a final survey is being made to make sure that no mistake will prevent the successful explosion of what is by far the largest blast ever attempted. The drawing, Fig. 6, is a longitudinal section through the galleries and shafts; it gives also a correct idea of the sloping character of the river bottom at this point.

Fig. 7 represents the cartridges and exploders. The dynamite cartridge No. 1 is 15 inches long by 2¼ inches in diameter; it is the last cartridge put in each drill hole, and it is so placed that its end projects about 6 inches beyond the face of the rock. In the forward or projecting end is placed an exploder, which consists of a thin, jumped-up copper shell filled with fulminate of mercury, the open end being pinched together and dipped in solder. No. 2 is the rack-a-rock cartridge with dynamite exploder, shown full size in No. 3. This cartridge is 24 inches long by 2¼ inches in diameter, and holds 6 pounds. Rack-a-rock is a mixture of chlorate of potash and dinitro-benzole; the ingredients are harmless until united. The mixing was done upon Great Mill Rock, in a lead-lined vat, the potash being made to pass through a fine sieve, and the benzole being then added in the requisite proportion. The explosive thus formed has 95 per cent the strength of No. 1 dynamite.

The cases are then filled with this substance, which looks like moist light brown sugar, a light wooden rammer forcing it gently into place. When filled, a cap is soldered upon each case. The alloy here used is very fusible, the soldering cap being only heated, by steam, to 112°. The filled shells are then placed in compartment boxes and carried to the galleries. At the bottom of each cartridge are four outwardly projecting wires, which serve to hold the cartridge in the drill hole The method of loading the holes was described and illustrated in our issue of July 25, 1885.

The dynamite exploder No. 3 (Fig. 7) consists of a copper tube filled with No. 1 dynamite, and provided with an exploder similar to that shown in No. 1. A cork stopper is placed in the open end of the tube, which is then dipped in glue and a copper cover put on. This exploder is pushed a short distance into the end of the rack-a-rock cartridge, as shown in No 2.

The dynamite cartridge is of the same size as the rack-a-rock, and is filled with No. 1 dynamite; it is furnished with a common fulminate exploder. The operation of forming a hole in the dynamite cartridge with a stick and inserting the exploder is shown in the engraving, Fig. 8. The cartridges are all dipped in oil and pitch and then rolled in sand, to protect them from corrosion.

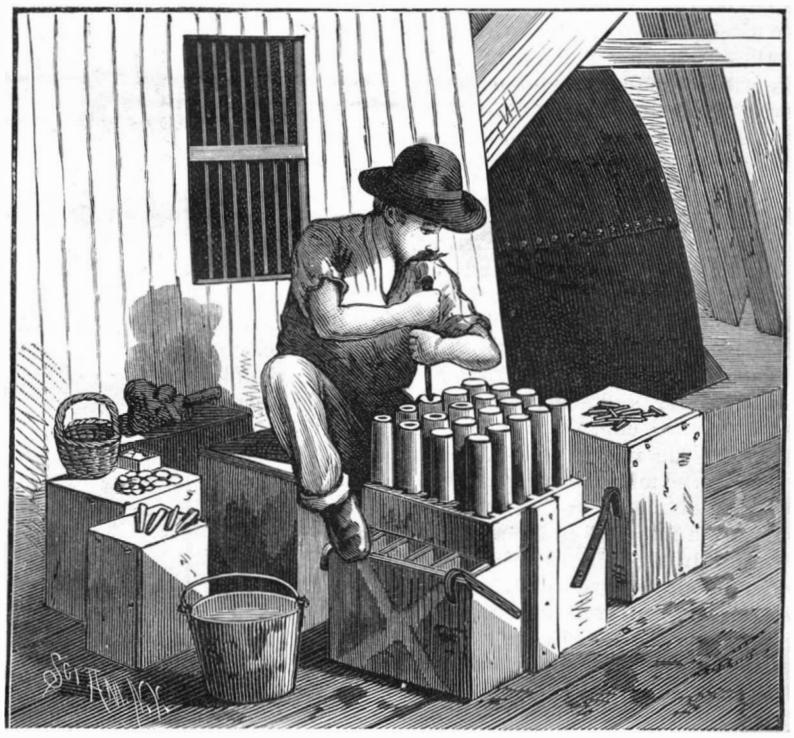

Fig. 8.—INSERTING EXPLODERS IN CARTRIDGES.

No. 5 shows the mine exploder (shown in position in the mine in Fig. 9), which is a brass cylinder 7½ inches long by 1¾ inches in diameter, filled with dynamite. Inclosed within the dynamite is a fuse (No. 5), the wires from which pass through a divided cork in the mouth of the brass cylinder. The fuse—shown full size in No. 4—consists of a copper tube nearly filled with 30 grains fulminate of mercury. Fitting within the open end of this tube is a second one containing sulphur, through which pass the two conducting wires, which are held firmly in place by the sulphur. The inner ends of the wires are united by a small platinum wire or bridge. The ends of the wires are then surrounded with fulminate, and the two parts are put together, that containing the wires slipping within the other. The entire fuse is then covered with gutta-percha. The passage of an electric current through the wires heats the platinum bridge to redness, when the fulminate is exploded.

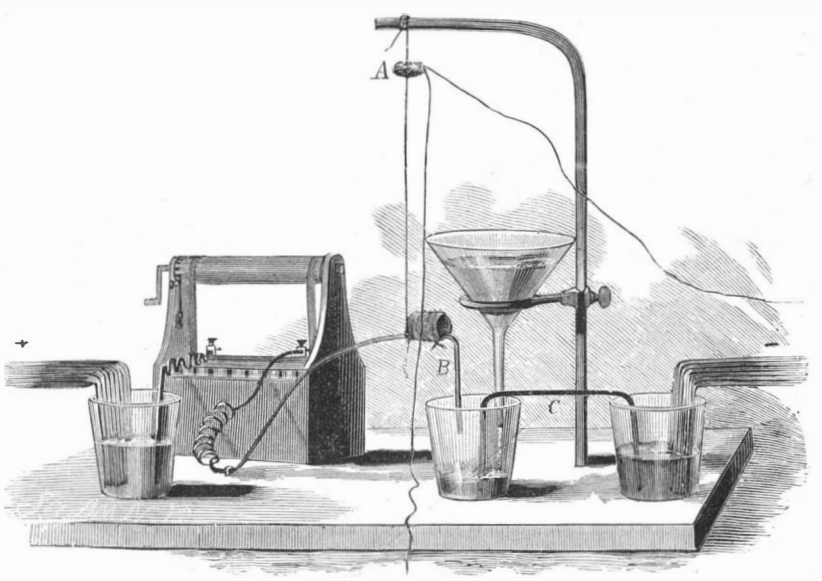

Fig. 10.—THE ELECTRICAL FIRING APPARATUS.

Each drill hole is nearly filled with rack-a-rock cartridges, space of course being left in the mouth to permit the entrance of the dynamite cartridge. We thus have each of the holes filled mainly with rack-a-rock, and from each projects a short length of tube having dynamite, and in every cartridge is an exploder.

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Not one of the cartridges in the drill holes is connected with wires, nor is one to be exploded by electricity.

Extending from wall to wall in each of the galleries, and at intervals of about 25 feet, are timbers, 3 by 5 inches, as shown in Fig. 9. Tied side by side upon each one of these timbers are two dynamite cartridges like those already described as filling the mouths of the drill holes. Tied upon each pair of these cartridges is a mine exploder, represented in No. 5 (Fig. 7). The entire mine is divided into 24 independent circuits, each circuit representing or covering a certain section. Within each circuit are 25 fuses or mine exploders.

A wire from the surface of the rock at the mouth of the shaft leads from one fuse to the next until the 25 fuses are in the same electrical circuit, the other end of the wire, of course, returning to the surface. Each of the 24 circuits has its own wire. The wire circuit is shown at 1 and 2, Fig. 9. We now come to the electrical firing apparatus, shown in Fig. 10. We will suppose one end of each wire of each circuit to be + and the other —. All the + ends are dipped in mercury contained in a cup, and all the — ends in mercury in a second cup. It will be seen that if the mercury in these two cups be united by a wire, we shall have a complete electrical circuit embracing every fuse or mine exploder in the excavation.

Leading from the left hand or + cup is a wire secured to one pole of a battery; and leading from the opposite or — cup is a wire, C, which extends to the bottom of the middle cup, which contains only a little mercury. The wire, B, leads from the other pole of the battery, and is held suspended over the mercury in the center cup. It is evident that, when the wire, B, enters the mercury in the center cup, the circuits through the mine and battery will be completed, and the fuses discharged.

At A is a fuse held to the string carrying the wire, B, by a half hitch. One wire passing through this fuse is grounded, while the other leads to the shore, where it also is grounded; a battery on shore is placed in this circuit. The current through the shore wire explodes the fuse, A, which breaks the cord and allows the wire, B, to drop into the mercury in the cup; the mine is then exploded. It will be observed that the wire, B, enters the cup a short distance. This is in order that the mine may be exploded even if anything should happen to the shore wire or battery, or if the explosion of the fuse, A, should fail to break the string holding up the wire, B. The outlet of a vessel containing mercury is placed over the center cup. It has been ascertained by experiment just how long it will take the mercury running from this vessel to fill the cup up to the end of the wire, B. The flow has been so gauged that after all the apparatus has been arranged, there will be ample time for the boat to go from Flood Rock to the shore; then the current will be sent through the shore wire.

Should the shore wire fail, there will be nothing to do but wait until the mercury has filled the cup to the wire, B. The shore connection was devised mainly for the benefit of scientists, who will be located in the vicinity, and who wish to make observations of the vibrations of the earth caused by the explosion. The current will notify them of the exact instant of explosion. The failure of the shore wire would of course deprive them of this most important point, but would interfere in no way, as mentioned above, with the firing of the mine.

The electrical current will explode the 600 fuses or mine exploders (Fig. 9), when the dynamite cartridges projecting from the drill holes will "explode by sympathy," as it is termed, and these in turn will discharge the rack-a-rock placed behind them. Each cartridge is rendered more sensitive by the exploder embedded in it. The explosion of the 40,000 cartridges containing 75,000 pounds of No. 1 dynamite and 240,000 pounds of rack-a-rock will completely break up the 9 acres in which they are buried, so as to render easy the final operation of dredging the broken rock. The cost of the improvement is estimated at $1,000,000.

The Harlem River improvement contemplates the building of a deep water channel from the East River through the Harlem River and Spuyten Duyvil to the Hudson River, as shown in the map, Fig 11. Above the Third Avenue bridge to the entrance of Dyckman'sCut into the Harlem, the pier and bulkhead lines will be 400 feet apart. The line through rock at Dyckman's Meadows will be 350 feet wide, and from there to the Hudson 400 feet wide. From Third Avenue bridge to lower part of Randall's Island the width will be 500 feet, and from there to the East River 800 feet wide. Between Morrisania and Randall's Island the channel will be 350 feet wide.

All the work at Hell Gate was designed by Gen. Newton, to whose perseverance, industry, and skill we owe the successful opening of one of the most important entrances to New York; the last operation—blowing up Flood Rock—fittingly completes, by its great magnitude and the rare difficulties it presented, long years of well directed effort. During the past few years the work at Flood Rock has been under the supervision of Lieut. G. McC. Derby, who has without accident of any kind, or any delay, succeeded in performing one of the most arduous pieces of mining ever attempted. We wish to acknowledge the kindness of Gen. Newton and Lieut. Derby, who furnished us data.

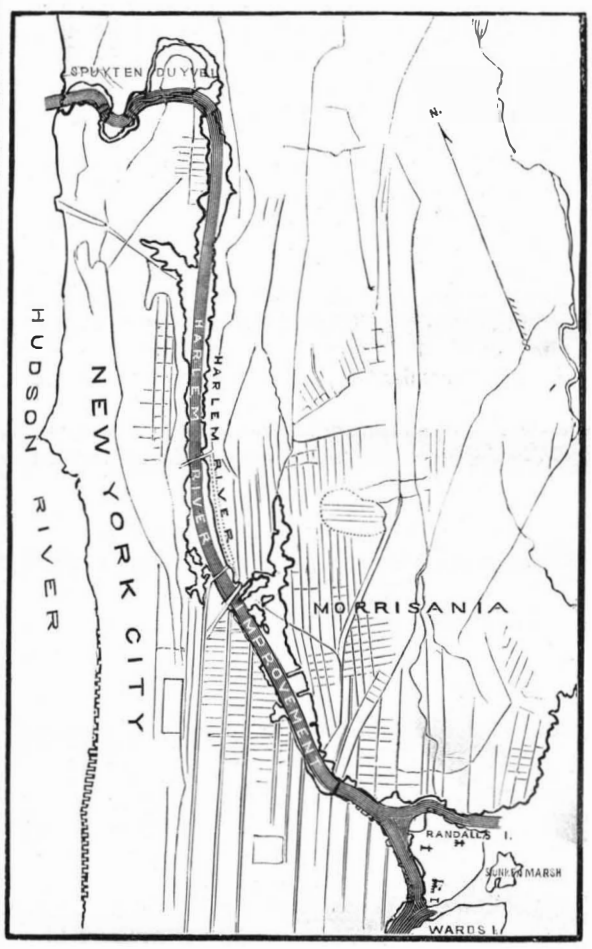
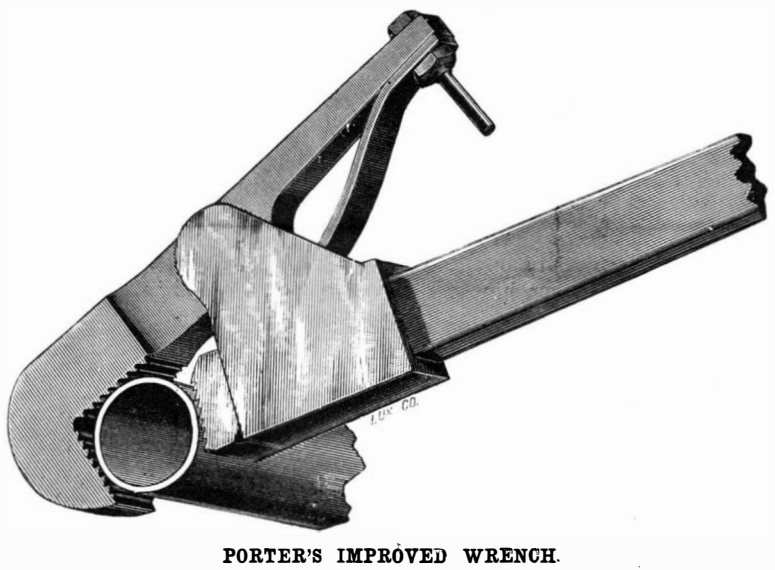


Fig. 11.—MAP SHOWING HARLEM RIVER IMPROVEMENT.

AN IMPROVED WRENCH.

The wrench shown in the accompanying cut has many admirable features—it adjusts itself to either pipe, nut, or stud; owing to the form of the forward or movable jaw, it can be used to fit corners about machinery that cannot be reached with other forms of wrenches; and owing to the fact that it has three bearings on the pipe, the latter is not liable to be crushed. The serrated or holding surfaces of the movable jaw are at right angles to each other; this jaw is pivoted in a fork projecting from the side of a fixed sleeve on the end of the handle, and a spring presses the holding portion of the jaw toward the end of the handles, which is also serrated. By pressing upon the rear end of the movable jaw bar, the jaws may be opened to their widest extent. The metal (best steel) is so distributed as to make those parts which are subjected to the severest strain exceedingly strong. The wrench is easy to handle, exerts a powerful grip, and may be instantly freed from the pipe. It is manufactured in sizes, taking pipe from one-eighth inch to five inches, the smallest size being provided with a screwdriver handle.



PORTER'S IMPROVED WRENCH.

This wrench is manufactured by the Porter Manufacturing Company, of Revere, Mass.; The Eaton, Cole & Burnham Company, of 82 and 84 Fulton Street, New York city, are sole agents.

An Electric Railway in Toronto.

The Vandepoele electric railway was recently put in operation in Toronto, in order to carry passengers from the horse cars to the fair grounds, a distance of one mile. Trips were made in two and a half minutes, and large numbers of passengers were carried over the road daily.

Rapid Steaming by the Etruria.

The Cunard steamship Etruria arrived at New York August 22, from Liverpool, having made the fastest trip in the record of Atlantic traveling. Time from Queenstown to Sandy Hook, 6 days 5 hours and 31 minutes. The fastest previous passages were made by the Oregon of the same line, and were: Westward, 6 days 10 hours and 10 minutes, just a year ago, and eastward, 6 days 6 hours 41 minutes, in December, 1884. The Etruria's previous trip eastward, reckoning to Fastnet only, was made in 6 days 5 hours and 35 minutes.

Following is a table of the runs made on the different days during the Etruria's last voyage:

Run.	Miles.
Liverpool to Queenstown	240
From leaving Queenstown to noon August 17	424
24 hours to noon August 18	464
24 hours to noon August 19	450
24 hours to noon August 20	465
24 hours to noon August 21	464
24 hours to noon August 22	465
From noon to 3:35 P. M. August 22	71
Total	3,043

The Etruria is built of steel, has a gross tonnage of 8,000 tons, and upward of 14,000 horse power; her length over all is 520 feet, and extreme breadth 57 feet 3 inches.

A Great Cargo of Lumber.

Mr. J. K. Ward, the well known Montreal lumberman, gives the following in the *Gazette* of that city:

Probably the largest cargo of sawed lumber that has ever been shipped from Canada left this port to-day per steamship Regius, Capt. Kayll, on account of Bryant, Powis & Bryant, of London, Eng. It consisted of 1,272 St. Petersburg standard three inch deals, or 2,518,560 feet board measure, equal to ten large barge loads of 250,000 feet each. If it were in one inch boards it would cover a farm of 60 acres, and require the pine product of say 1,000 acres of ordinary forest land, such as we have to depend on for our future supply. This shipment may suggest to the minds of many the great importance of the future of our leading industry. There is no questioning the fact that our country is fast being depleted of one of its most important elements of prosperity, and that it behooves not only the lumbermen and the government, who are directly interested, but also every member of the community, to do what they can by expression of opinion or otherwise to protect that that cannot be reproduced in our day.

Texas Copper Deposits.

According to a Texas newspaper, the copper region of that State is of great extent, running westward from Red River, from the line of the Indian Territory, through several counties, prominent among which are Archer, Baylor, Knox, Hardeman, and Cottle. The district is approximately in latitude 32 degrees north, with Red River to the north as well as the east, and the Brazos River to the south. The copper deposits were discovered by General George B. McClellan, in 1852. In that year, McClellan, then a lieutenant in the army, was detailed by Jefferson Davis, Secretary of War, to accompany an expedition up Red River into Texas and Indian Territory. While on this duty Lieutenant McClellan found important deposits of rich copper ore near the point where Cache Creek empties into the river, and some miles above it was discovered that Red River flowed through apparently solid beds of the valuable mineral. In the same locality rich gold bearing quartz veins and placers were found, and all the conditions pointed to the existence of a mining district of great possibilities. To complete the romantic history of the discovery of copper in Texas, it is only necessary to add that General McClellan is now, after the lapse of a third of a century, the leading spirit engaged in the development of the deposits. The Grand Belt mines, in which he is largely interested, are fifty miles from Harrold, in Wilbarger county, from which latter point forty wagons are at present engaged in hauling coke to the smelter. The smelter is an experiment, but has a capacity of forty tons per day, and is suitably provided with engine, blower, pumps, etc. All told, the McClellan company's patented claims embrace some 36,000 acres, stretching sixty-five miles along the ore belt. Upon this vast property they have made probably sixty shallow openings of an average depth of seven or eight feet. The ore is found principally in shallow pockets, and at the main point of taking out is said to average about 54 or 55 per cent metallic copper. Some of it is supposed to be very rich in silver. The most promising opening at present being worked by the company is at Kiowa Peak, the center of Motley County, some sixty miles west of Margaret, the county seat of Hardeman County.

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Science Leads to Economy of Time and Labor.*

How exultant is the old Greek poet Antipater ("Analecta Veterum Græcorum," Epig. 39, vol. ii., p. 119) when women are relieved of the drudgery of turning the grindstones for the daily supply of corn! "Woman, you who have hitherto had to grind corn, let your arms rest for the future. It is no longer for you that the birds announce by their songs the dawn of the morning. Ceres has ordered the water nymphs to move the heavy millstones and perform your labor." Penelope had twelve slaves to grind corn for her small household. During the most prosperous time of Athens it was estimated that there were twenty slaves to each free citizen. Slaves are mere machines, and machines neither invent nor discover. The bondmen of the Jews, the helots of Sparta, the captive slaves of Rome, the serfs of Europe, and uneducated laborers of the present day, who are the slaves of ignorance, have added nothing to human progress. But as natural forces substitute and become cheaper than slave labor, liberty follows advancing civilization. Machines require educated superintendence. One shoe factory in Boston by its machines does the work of 30,000 shoemakers in Paris, who have still to go through the weary drudgery of mechanical labor. The steam power of the world, during the last twenty years, has risen from 11½ million to 29 million horse power, or 152 per cent.

Let me take a single example of how even a petty manufacture improved by the teachings of science affects the comforts and enlarges the resources of mankind. When I was a boy, the only way of obtaining a light was by the tinder box, with its quadruple materials, flint and steel, burnt rags or tinder, and a sulphur match. If everything went well, if the box could be found and the air was dry, a light could be obtained in two minutes; but very often the time occupied was much longer, and the process became a great trial to the serenity of temper. The consequence of this was that a fire or a burning lamp was kept alight through the day. Old Gerard, in his Herbal, tells us how certain fungi were used to carry fire from one part of the country to the other. The tinder box long held its position as a great discovery in the arts. The *pyxidicula igniaria* of the Romans appears to have been much the same implement, though a little ruder than the flint and steel which Philip the Good put into the collar of the Golden Fleece in 1429 as the representation of high knowledge in the progress of the arts. It continued to prevail till 1833, when phosphorus matches were introduced, though I have been amused to find that there are a few venerable ancients in London who still stick to the tinder box, and for whom a few shops keep a small supply. Phosphorus was no new discovery, for it had been obtained by an Arabian called Bechel in the eighth century. However, it was forgotten, and was rediscovered by Brandt, who made it out of very stinking materials in 1669.

Other discoveries had, however, to be made before it could be used for lucifer matches. The science of combustion was only developed on the discovery of oxygen a century later. Time had to elapse before chemical analysis showed the kind of bodies which could be added to phosphorus so as to make it ignite readily. So it was not till 1833 that matches became a partial success. Intolerably bad they then were, dangerously inflammable, horribly poisonous to the makers, and injurious to the lungs of the consumers. It required another discovery by Schrotter, in 1845, to change poisonous waxy into innocuous red-brick phosphorus, in order that these defects might be remedied, and to give us the safety match of the present day.

Now, what have these successive discoveries in science done for the nation, in this single manufacture, by an economy of time? If before 1833 we had made the same demands for light that we now do, when we daily consume eight matches per head of the population, the tinder box could have supplied the demand, under the most favorable conditions, by an expenditure of one-quarter of an hour. The lucifer match supplies a light in 15 seconds on each occasion, or in 2 minutes for the whole day. Putting these differences into a year, the venerable ancient who still sticks to his tinder box would require to spend 90 hours yearly in the production of light, while the user of lucifer matches spends 12 hours; so that the latter has an economy of 78 hours yearly, or about 10 working days. Measured by cost of production at 1s. 6d. daily, the economy of time represented in money to our population is £26,000,000 annually. This is a curious instance of the manner in which science leads to economy of time and wealth even in a small manufacture.

In larger industries the economy of time and labor produced by the application of scientific discoveries is beyond all measurement. Thus the discovery of latent heat by Black led to the inventions of Watt, while that of the mechanical equivalent of heat by Joule has been the basis of the progressive improvements in the steam engine, which enable power to be obtained by a consumption of fuel less than one fourth the amount used twenty years ago. It may be that the engines of Watt and Stephenson will yield in their turn to more economical motors; still they have already expanded the wealth, resources, and even the territories of England more than all the battles fought by her soldiers or all the treaties negotiated by her diplomatists. The coal which has hitherto been the chief source of power probably represents the product of five or six million years, during which the sun shone upon the plants of the carboniferous period, and stored up its energy in this convenient form. But we are using this conserved force wastefully and prodigally; for, although horse power in steam engines has so largely increased since 1864, two men only now produce what three men did at that date. It is only three hundred years since we became a manufacturing country. According to Professor Dewar, in less than two hundred years more the coal of this country will be wholly exhausted, and in half that time will be difficult to procure. Our not very distant descendants will have to face the problem —What will be the condition of England without coal? The answer to that question depends upon the intellectual development of the nation at that time. The value of the intellectual factor of production is continually increasing, while the values of raw material and fuel are lessening factors. It may be that when the dreaded time of exhausted fuel has arrived, its importation from other coal fields, such as those of New South Wales, will be so easy and cheap that the increased technical education of our operatives may largely overbalance the disadvantages of increased cost in fuel. But this supposes that future governments in England will have more enlightened views as to the value of science than past governments have possessed.

Industrial applications are but the overflowings of science welling over from the fullness of its measure. Few would ask now, as was constantly done a few years ago, "What is the use of an abstract discovery in science?" Faraday once answered this question by another, "What is the use of a baby?" Yet round that baby center all the hopes and sentiments of his parents, and even the interests of the State, which interferes in its upbringing so as to insure its being a capable citizen. The processes of mind which produce a discovery or an invention are rarely associated in the same person, for while the discoverer seeks to explain causes and the relations of phenomena, the inventor aims at producing new effects, or at least of obtaining them in a novel and efficient way. In this the inventor may sometimes succeed without much knowledge of science, though his labors are infinitely more productive when he understands the causes of the effects which he desires to produce.

* From Sir Lyon Playfair's address, British Association, Aberdeen.

An Architect's Responsibility.

An architect is the chief builder, according to the correct derivation of the word, but his responsibility for the safety, stability, and permanency of works that are being executed under his direction is a different one from that of the real builder. The builder is directly responsible, not alone for accidents which may occur in building operations (all of which he may make good financially), but also for loss of life and injury that may happen to any of the workmen in his employ, if the same occurs through negligence to provide the proper labor and material necessary to carry on the work in safety. It is not always easy to draw the line at the point where an architect's responsibility ends and that of a builder begins. There are such hazy notions prevalent in regard to an architect's superintendence, and the amount of responsibility it entails, that it is difficult to fix responsibility in any given case. The American Institute did not help matters much by their somewhat elaborate definition of superintendence. In this there was a distinct effort to define the duties of an architect as regards superintendence, and especially to show that an architect was not a clerk of works, and bound to devote an unlimited amount of time in superintending. There was nothing, however, intending to fix responsibility for poor work. This is left, wisely or unwisely, to the parties directly concerned, in case it should be necessary to determine responsibility. It seems to us that a general principle can be laid down which, if borne in mind, might prevent misconceptions. Let it be understood, first of all, that an architect by superintendence does not assume what must necessarily always be a builder's risk, *i. e.*, the risk arising from imperfect materials or poor labor. Even if an architect has passed upon a portion of the work which is afterward found defective, the builder is not thereby relieved, and in any event he cannot transfer his direct responsibility for poor work, no matter when or how detected. On the other hand, an architect is clearly responsible for the result, in case his plans and specifications are strictly followed, and the construction has been according to his directions. If it should transpire in any case where a defect was found, that it was due to imperfect design, poorly conceived planning, or bad construction, either theoretical or practical, we think an architect becomes liable for damages The trouble is, however, to prove that the defect was brought about by any such cause. We speak of legal proof—of the kind necessary to sustain action for damages—not of the conviction which every well-informed man has, after examining into a defect, as to the cause of it. For instance, suppose a building turn out when done to be poorly lighted and ill ventilated, or that the rooms are planned in an impracticable manner, or that there are various absurd and crazy features which will entail future expense in repairs, or that there are any features which will not adjust themselves to the practical requirements for which the building was built. An architect is certainly responsible for any such mistakes, and yet we have never heard of an action to recover based on them.

A case like the following will illustrate the difference between the architect and builder as to responsibility for a disaster: Suppose a high wall of masonry, where there were tall windows separated by piers, should fall down. The responsibility for this would depend, first, on the question of labor and material being all right; second, as to whether the proper precautions had been used; and third, as to whether the wall itself or through weak piers was unstable according to the plans. If on investigation it turns out that the mortar was poor, or that the stones were poorly bonded, or that the wall was not secured in any way while building—no shoring supports being used—then the builder has to bear the blame and sustain the money loss. If the builder alleges that the architect saw the mortar frequently without remark, and gave no directions concerning securing the wall, and that hence he is also responsible and liable, the claim is not good, and cannot be sustained. It is possible that poor mortar and imperfect work *may* escape the closest supervision, although, of course, this is not likely to occur with a thoroughly capable superintendent. Even the capable superintendent may be cheated, however, in the most ordinary building operations. Hence it is just to hold the builder responsible for any disaster due to imperfect work or materials, even if the superintending architect has passed upon the work that is involved. The principle at stake here is one that finds expression in many contracts, as follows: "Under the superintendence of ———, architect, who shall have full right *at any time* to reject such work or material as does not, in his opinion, conform to the true meaning of the plans and specifications." The words "*at any time*" are unmistakable in their meaning, but even without them the principle will be sustained, that the safety of the walls is at the sole risk of the builder, as far as ordinary imperfections are concerned. The architect would be responsible for the fall of the wall in case it was established that it was inherently weak in its design, and that good material and labor were not sufficient to make it stable. The wall might not be thick enough for the height to which it was carried, or the piers dividing the windows might be too weak structurally. Any such cause of trouble as this clearly lays the blame upon the architect's shoulders. Further than this, if the materials have been according to specifications, and it is established that they were inadequate to do the work they were called upon to do, the architect must be held liable.

Sometimes an accident occurs where no one is really to blame, and there is difficulty in fixing upon the person who is liable; at least, there is a disposition to waive responsibility where there is no blame attached. Suppose a truss should give way, causing the fall of a roof, and upon investigation it was found that it was owing to a defect in the iron tie rod—a defect that might have stood the test at the mill, and of such a nature that no one could be aware of it. The builder, feeling that he was not to blame for the disaster, not unnaturally seeks to evade financial responsibility, but he is liable to the owner nevertheless, and he in turn ought to recover damages from the people of whom he bought the rod.

To the earnest architect every really important building that he has charge of brings a higher kind of responsibility than the kind we have been discussing. Whether the builder is technically liable or not, the architect is morally liable, and no mishap can occur without damage to his fame. An architect literally has to entrust his reputation to the builder and his workmen, and the public will hold him strictly responsible, justly or unjustly.—*Building.*

ALFRED E. MOORE, of Winsted, Conn., made a forty-six mile journey in thirty-five minutes in a balloon, the 24th of September. The trip was made at an average of 6,000 feet above the earth, and from this altitude he could see the cities of Hartford, New London, New York, New Haven, and Bridgeport, like mere dots, through the glass. In speaking of his experience, he said: "Balloons, in descending, frighten the crows and poultry terribly. Going over farmhouses, I never heard such a racket in my life. When you are far up and above the clouds, the awful silence is terrible. You can hear the watch tick in your pocket, and the snapping of a straw hat will make you start. The rushing of blood through your whole body is an experience you wouldn't care to have lost. There is no sensation of moving along, when, perhaps, you are going at the rate of a mile a minute, and everything is as still as death.'

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IMPROVEMENT IN SMALL GAS ENGINES.

The greatest difficulty experienced by the manufacturer of machinery to be used by everybody is generally with the user. The majority of people are to a great extent unmechanical, at least they have little practical knowledge of the use of machinery, therefore the machinery must suffer. Every wise manufacturer of machinery for general use will be governed by this fact, and, rather than try to educate his patrons, will simplify his machinery, and, so far as possible, will adapt it to existing conditions.

What we have said with regard to machinery in general applies with peculiar force to gas engines, especially

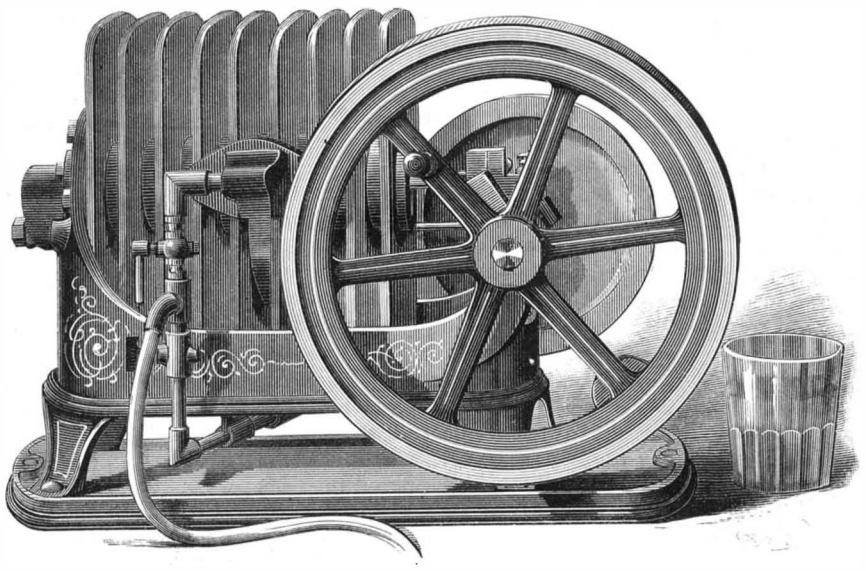

Fig. 1.—GAS ENGINE FOR SMALL USES.

of the smaller sizes, which, with scarcely an exception, have been quite complex, so much so as to render a considerable amount of instruction of great importance to the user.

We believe, however, the makers of the engines shown in the accompanying cuts have duly considered the necessity of great simplicity in small motors designed to be universally used.

These engines consist practically of but three moving parts—the piston, the crankshaft, and the exhaust valve. The piston does treble duty: first, that of transmitting the pressure generated by the explosion of gas in the cylinder; second, as a valve for controlling the admission of gas and air to the cylinder; and third, as an ignition valve for admitting the igniting flame to the cylinder.

Figs. 1 and 2 show two forms of this engine, which differ mainly in appearance, the working parts being substantially the same in both. The smallest engine made by the Economic Motor Company is that shown in Fig. 1. It is adapted to such small uses as driving sewing machines, dental engines, mechanical signs, small ventilating fans, etc. It is perfectly portable, requiring no water for cooling the cylinder.

The one horse power engine, shown in Fig. 2, is used for a large variety of purposes, including the driving of small shops for metal and woodworking, coffee mills, water pumping, etc. Two smaller sizes of this type of engine are made, which are respectively one-half horse power and one-eighth horse power.

The construction of the engine will be understood by reference to Figs. 3 and 4.

The cylinder, A, contains a piston, D, having a hollow cylindrical prolongation, D′, whose length is a little greater than the stroke of the engine. The forward end of the piston is connected with the crank, C, in the usual way. In one side of the cylinder there is an air and gas port, *c*, communicating with the air pipe, F; and below the port, *c*, there is an auxiliary air port, *d*, communicating with a division, G, of the air pipe, F. In the side of the cylinder, A, opposite the port, *c*, there is an ignition port, *a*, opposite which is continually maintained the igniting flame by the Bunsen burner, *o*.

The hollow cylindrical prolongation of the piston, D, has ports, *a′ c′ d′*, which coincide with the corresponding ports, *a c d*, in the cylinder during both the outstroke and in-stroke of the piston. Within the ignition port, *a′*, in the piston is supported a deflector, *b*, which directs the igniting flame toward the open end of the piston.

An exhaust passage, *f*, in the cylinder head leads to an exhaust valve, consisting of a valve casing, *e′*, and a cylindrical valve, *g′*, sliding therein. The valve, *g′*, is moved by an eccentric or cam on the main shaft, through the rod, *j′*. The operation of the engine is as follows: The igniting flame being lit, and gas being allowed to flow continuously through the pipe, *l*, into the compartment, *h*, of the air pipe, F, the flywheel is turned, moving the piston, D, outward, forming a partial vacuum in the cylinder, A, into which a mixture of air and gas passes through the ports in the cylinder and piston into the prolongation of the piston, air only entering through the ports, *d d′*. When the piston has made something less than one-half of its out-stroke, the air and gas port is closed by the piston in its forward movement, and the ignition ports, *a′ a*, coincide when the igniting flame is drawn in and the charge contained by the cylinder is exploded; but before the full force of the explosion is reached, the port, *a*, in the cylinder is closed by the forward motion of the piston, so that there is very little escape through the ignition ports.

The explosion propels the piston forward and turns the shaft, storing in the flywheel sufficient power to do the work required during the remainder of the revolution, to return the piston to the point of starting, and to draw in a new charge of gas and air. While the piston is making its return stroke the exhaust valve is open, allowing the products of combustion to escape. One turn of the flywheel is sufficient to start the engine.

These engines make from 150 to 300 revolutions per minute, and as the crank receives an impulse for every revolution, the motion is uniform. No gas bag is used or needed with this engine, and the manner of introducing the gas renders the engine to a great extent self-regulating. Either coal gas, water gas, or gasolene gas may be used in these engines.

The gas supply valve in the larger engine is kept open by the pressure generated in the cylinder, and when the pressure ceases the gas is automatically shut off.

We are informed these engines are largely in use, and are giving general satisfaction.

The offices of the Economic Motor Company are at 9 Cortlandt Street, New York city.

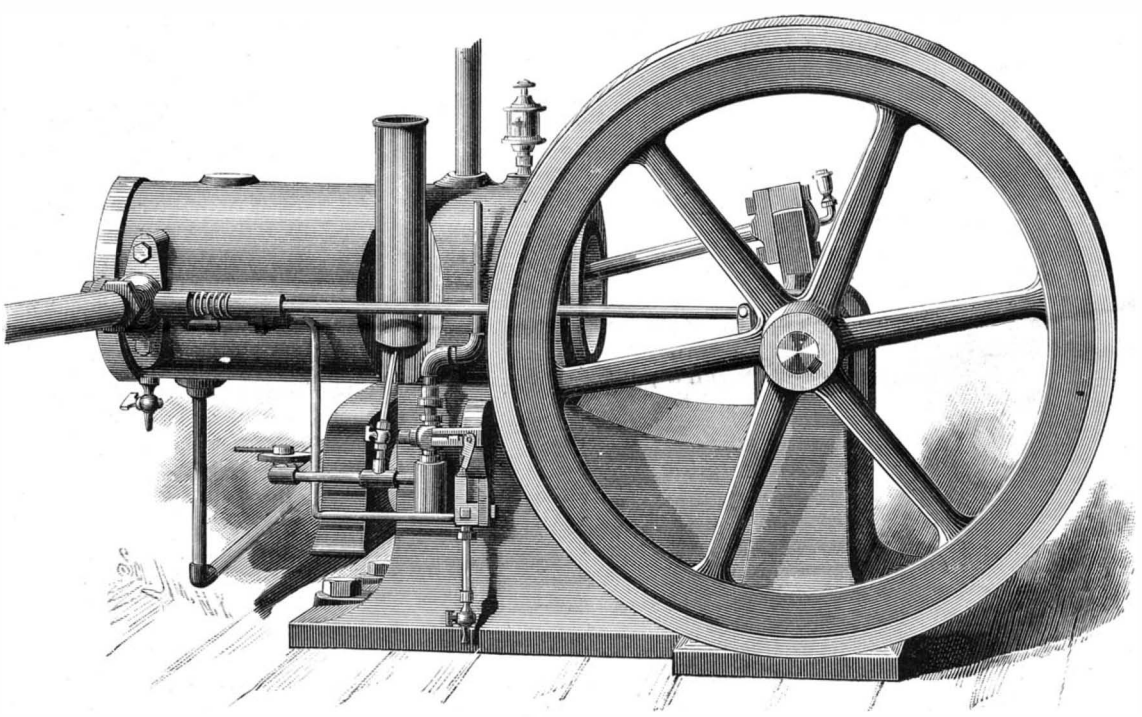

Fig. 2.—SIMPLIFIED GAS ENGINE MADE BY THE ECONOMIC MOTOR CO.

Aerial Navigation.

The Paris correspondent of the *Herald* cables the result of a fresh attempt on the part of Captain Renard and his brother to make the much desired art of ballooning a practical success. Ascents were made from the Camp of Chalais on two different occasions, and though the aerial voyage was short, it was sufficiently successful to satisfy the War Office authorities that the problem had apparently been solved. It is, however, stated that the cost of working Captain Renard's balloon is still prohibitive, and that it cannot be controlled for a long interval of time. On each occasion the balloon rose suddenly in midair, and, after remaining motionless for a short time, pursued a comparatively steady course toward the Point du Jour, about three miles from the starting point. Here a short pause and slight descent were made by the balloon, but it obeyed the steersman wonderfully, and sailed back to the Camp of Chalais, allowing a comfortable descent. It is too much to say that the problem has been solved, for the same premature announcement has often been made before; but it is at least encouraging to learn that the aeronauts accomplished a definite journey in place of the aimless wanderings which are the usual records of journeys in the air. It has ceased to be much of a

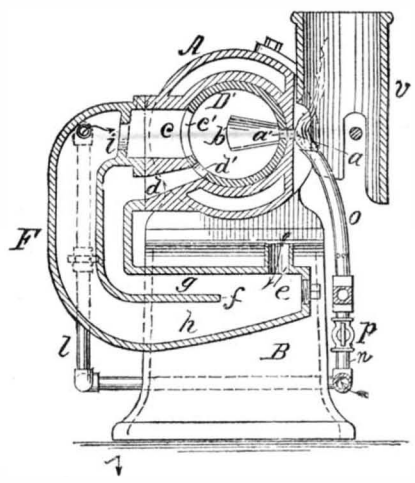

Fig. 3.—TRANSVERSE SECTION OF GAS ENGINE CYLINDER.

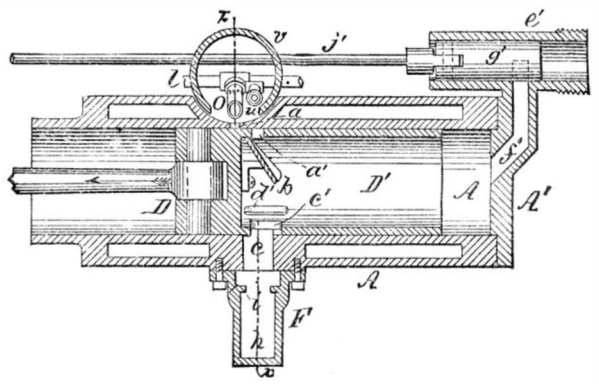

Fig. 4.—LONGITUDINAL SECTION OF GAS ENGINE CYLINDER.

feat to make a simple ascension, but it is still rather novel to have the balloon return to its starting point.

In company with Captain Krebs, Captain Renard, it will be remembered, made quite a celebrated voyage from Meudon to Bellancourt and return in the fall of 1884, in which he demonstrated the complete success of his steering apparatus. His balloon was cigar-shaped, and pointed at each extremity instead of simply underneath, as is usually the case. The car was provided with seats for two aeronauts, and the balloon had a directing apparatus and rudder. The power was furnished by a series of storage batteries of a total capacity of ten horse power, and the balloon could be operated for four hours at a time. If persistence be a virtue worthy of reward, we may certainly expect the construction of an entirely successful balloon, for there are few problems which have secured more careful and persistent efforts in the face of great difficulties than that of aerial navigation. The progress has been slow of necessity, from our ignorance of the requisite conditions, but a marked advance has been accomplished during the past two years, and warrants a belief in ultimate success.

A CORRESPONDENT, describing himself as "a country mechanic," writes us of having spliced a wire cable in 1872, which has been in use ever since, so that at the time of splicing not one in one hundred mechanics who examined the cable could tell where the ends were joined. The job took about eight hours.

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CHAIR ELEVATOR FOR USE AT FIRES.

The rapidity of elevating firemen with hose to any required point between the basement and roof of the highest building is the chief feature of this remarkably simple device, and renders it valuable to the owner, fire department, and insurance company. Firemen carrying the hose, without exertion on their part, are elevated by the chair to the locality of the fire, without the necessity of awaiting the arrival and placing in position of ladders, the entire weight of hose and of the water being supported by the chair. The same applies to the use of the Fire Patrol in carrying their cover to any height in the building. The severe strain and exhaustion now consequent in carrying the hose and covers up-stairs, or raising them on the ladders, is entirely done away with. For rescuing persons and those overcome and helpless, it is also very admirable. While it is always ready for instant use, and may easily be brought into operation, it does not mar the appearance of the front of the building.

Its parts are few and simple, and are so arranged as not to become clogged or out of order. The device consists of a chair weighing about fifty-six pounds, made entirely of steel, and operated by means of five hundred feet of steel wire cable capable of raising 3,000 pounds.

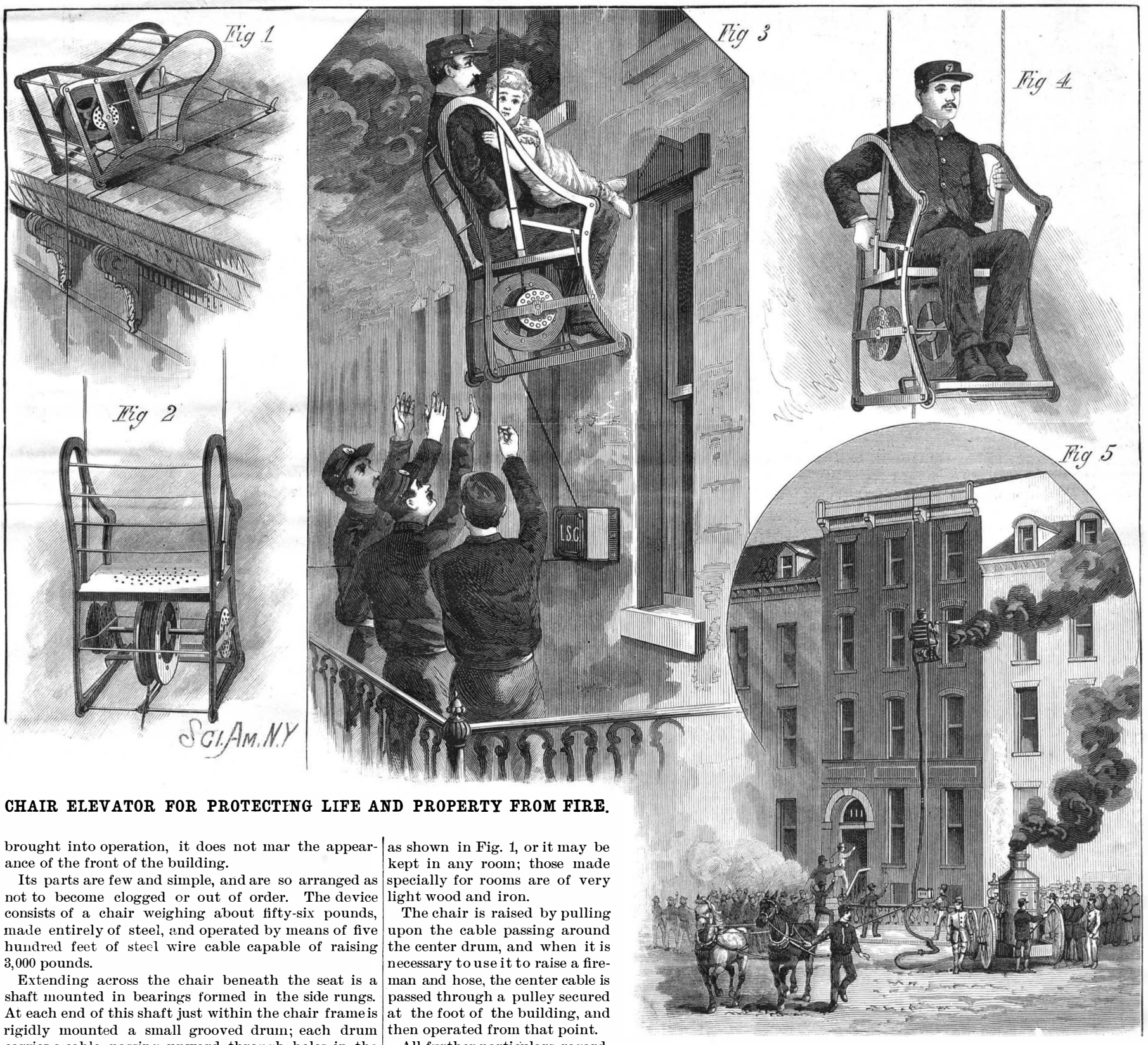
Extending across the chair beneath the seat is a shaft mounted in bearings formed in the side rungs. At each end of this shaft just within the chair frame is rigidly mounted a small grooved drum; each drum carries a cable passing upward through holes in the seat and in the tops of the arms. By means of this cable the chair can be suspended from any suitable point on the building. The ends of the cable are wound about the drums in the same direction. At the center of the cross shaft is mounted a large drum, about which is wound, in a direction opposite to that of the cable on the small drums, one end of a cable whose other end extends to the ground, being guided to the drum by passing between two rods uniting the lower front and rear crossbars so as to form a long and narrow slot. In each side edge of this drum is a groove to receive a strap brake; both straps are joined at one end to a bar uniting the lower side rungs, and after passing around the drum are joined to a movable foot rest consisting of a frame pivoted to the lower rear rung of the chair and extending forward so as to support the feet of the occupant. By pressing upon this frame the straps are bound against the edge of the large drum, and by the friction thus created the revolution of the shaft and the descent of the chair can be regulated.

Extending across the chair immediately below the seat is a shaft provided at its center with an arm, in the end of which is pivoted a rod connecting with the foot rest. Rigidly secured to the right hand end of this bar is a handle extending up to within convenient reach of the person in the chair. This handle moves along a curved catch bar, and can be locked at any desired point. Moving this handle forward and downward moves the foot rest downward and brings the brake into action. Thus the rapidity of the descent of the chair can be perfectly governed either with the hand or feet of the operator, as well as from the street below. The front standards of the frame are curved inwardly as shown in the drawings, and at each corner is a roller to admit of the chair rolling easily along the front of the building and over obstructions.

As the weather will not affect the chair, it can lie upon the eaves of the roof at all times ready for use, as shown in Fig. 1, or it may be kept in any room; those made specially for rooms are of very light wood and iron.

The chair is raised by pulling upon the cable passing around the center drum, and when it is necessary to use it to raise a fireman and hose, the center cable is passed through a pulley secured at the foot of the building, and then operated from that point.

All further particulars regarding this device can be obtained by addressing the Life and Property Saving Chair Co., 35 Broadway, N. Y.



CHAIR ELEVATOR FOR PROTECTING LIFE AND PROPERTY FROM FIRE.

The Busy Honey Bees.

A writer on this topic, alluding to this year's product, says:

The full harvest has not been gathered, but every beekeeper is now in possession of a part of the year's crop, and knows approximately what the whole will be. Returns are incomplete, but, as far as heard from, the yield of honey has been equal to that of an average year. The season has been favorable in greater part, although an occasional fall of the mercury has hindered comb building and interfered with the "building up" process. During August, certainly, the beekeeper expects to hear the "mighty hum" of the bees if he be near a hive. If no sound proceeds from a hive in July or August, it shows an unusual state of the weather. Last winter, when the mercury was ten degrees below zero, a thermometer was thrust into a cluster of bees. On the inside of the cluster the temperature was 65 degrees, and on the outside 45 degrees Fahrenheit. If the heat generated by the bees, when the mercury is 10 below, is 65 degrees, what must it be when the outside temperature is 90 degrees? It is intense, but the bees have a way of reducing it, at least a way of creating a draught and keeping the atmosphere pure.

A number of bees—a thousand or more, perhaps—act as ventilators or fanners. They stand, heads down, with bodies at an angle of 45 degrees, and keep the wings in motion. Throughout the hive, on all the combs, up and down, the ventilators keep their fans going. On the alighting board, with bodies pointing from the hive, they fan also. At the entrance of one hive, on a day in August, two hundred and eighty bees, by actual count, were fanning. The honey gatherers dropped down upon them, tumbled over them, but they kept to their work. Some writers have spoken of the "hum of the hive," as though the hum was the result of the work going on within. 'Twas the hum of the fanners. But in August this year there were nights when the hives were silent. Not an echo of a hum came from any, showing that the air was cold enough to dispense with the ventilators.

California bees have for several years been a principal source of the honey supply. The honey crop of that State is this year a failure, and the price of honey is therefore likely to advance.

THE mechanics of Brooklyn will be glad to learn that the Young Men's Christian Association entered their splendid new building, 502 Fulton Ave., on October 1. Among the various classes for the coming season organized by the Committee of Education will be one of a class in mechanical drawing. The Committee has made a special effort to secure a teacher having had shop experience, to teach members with reference to their calling. This will be a fine opportunity for young mechanics.

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THE CAR COUPLER TRIALS AT BUFFALO, N. Y.

The Executive Committee of the Master Car-Builders' Association met at Buffalo, N. Y., on the 15th of September, in order to make a practical trial of the various car couplers which are now in the market. It was its purpose to select those best suited for railroad requirements, and then to watch their record to within a month of the time of the next convention of the Association, so that it could prepare a report, and recommend the universal adoption of one or more of the successful competitors. The committee consisted of representative railroad men, and though their task was not easy, they seem to have accomplished it in a manner which gave general satisfaction to those interested. The conditions required by the committee prevented many inventors from being represented; but these conditions cannot be called unjustly severe, for they simply anticipated the requirements of every day use. No models or drawings of any kind were considered; it was an imperative condition of the trial that all couplers submitted for examination should be applied to two ordinary freight cars, so that they could be subjected to practical tests. The couplers were first tested on a straight and level piece of track, or, as the railroad men would say, on a level tangent. The points which the committee endeavored to ascertain with regard to each coupler were whether it would couple with the standard link, whether it would couple with its own kind at a slow speed and also when the two cars were brought together sharply, and finally, whether it could be set *not* to couple when the cars were brought together sharply. Some confusion existed in regard to the dimensions of a standard link; that used was 10½ by 1¾ inches inside measurement, but several gentlemen present stated that a link 2 inches wide inside would more properly represent the standard. The second series of tests were made on a 20° 20′ curve (282 feet radius), and with the center of the drawbar of one car 3 inches above the corresponding point in the other car. Many couplers which had passed the first trials satisfactorily failed entirely under the conditions of the second. The inventors were also required to furnish a set of drawings and specifications of their couplers, giving in detail the cost and weight of each part, and the total cost of applying the device to a new car, and to a car already supplied with the ordinary link and drawhead. Forty-six couplers in all were entered for competition, but as four of these failed to put in an appearance, the total number tested was but forty-two. We are indebted to the *Railroad Gazette* for the details of these tests and for our illustrations. The investigations consumed three days, and after several hours' additional deliberation with closed doors, the committee announced that they had decided to recommend the following couplers for further trial in actual service:

CLASS A.—LOOSE LINK.

1. *McKeen*, exhibited by T. L. McKeen, of Easton, Pa., is constructed of wrought iron and provided with a dead block, but no buffer. The pin is supported by a spring plunger, and the link guided by a patent controller. The test of this coupler was entirely satisfactory, but it must be coupled with the old style by hand, which is undoubtedly a disadvantage; otherwise it is automatic.

2. *Perry*, a Chicago invention, is made of cast iron, has a dead block, and is without a buffer. The pin is supported by a dog, and the link is guided. It also must be coupled with the old style by hand, but is otherwise automatic. It has been in use for two years.

3. *Archer*, of Albany, N. Y., has a dead block, but no buffer. A long vertical hook inside of the drawhead is substituted for the pin. It is operated by a spring, and is automatic.

4. *Gifford*, is provided with a buffer, has a loose link and a pin which can be set not to couple, but which cannot be removed from the drawhead. It operates by gravity, and is automatic. The tests were all satisfactory.

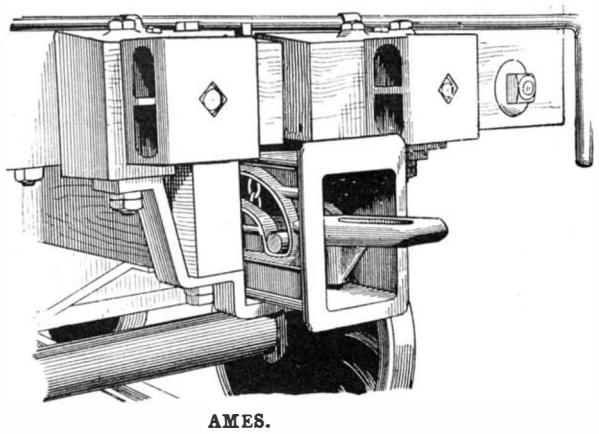
5. *Marks*, exhibited by C. E. Marks, of Flint, Mich., employs a long vertical hook raised by an eccentric, in place of a pin, and is operated by a spring.

CLASS B.—FIXED LINKS.

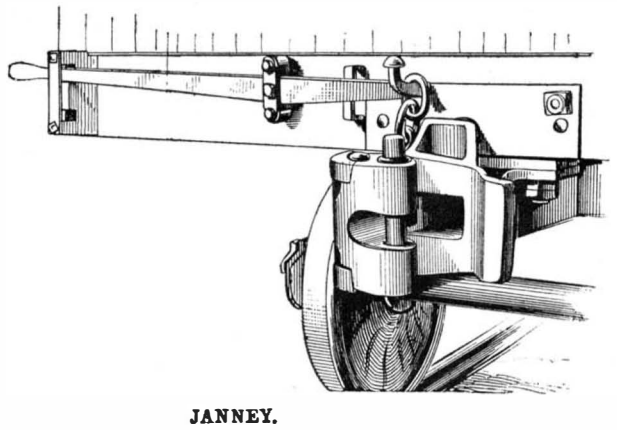
6. *Ames*, made of wrought iron and Siemens steel, has a fixed link pivoted in the center, balanced at the inner end, and provided with a hook on its under side. It operates by gravity, and is automatic, except when it is to be coupled with the old style drawbar and link.

CLASS C.—VERTICAL PLANE.

7. *Dowling*, Columbus, O., made of malleable iron, with buffer; has a knuckle, opened by a spring and locked by a vertical key. It operates by gravity, and must be coupled with the old style by hand.



AMES.



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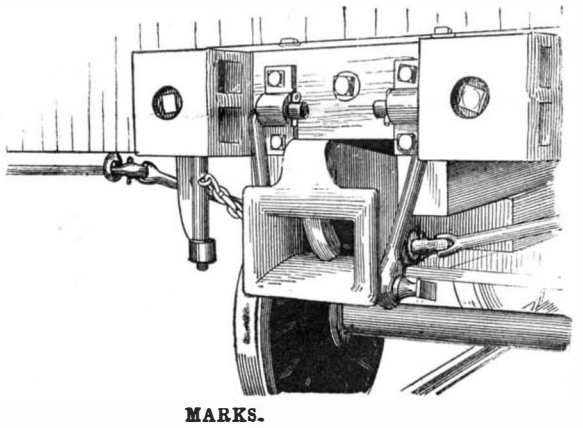

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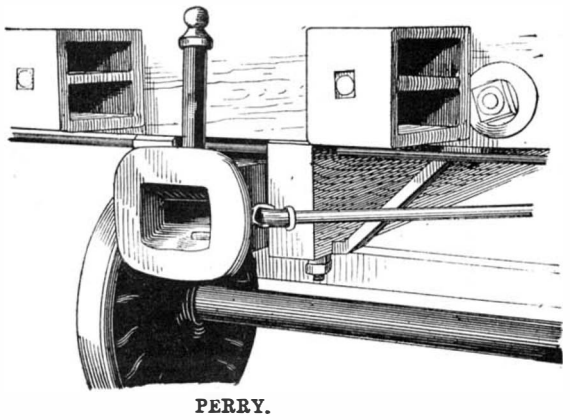

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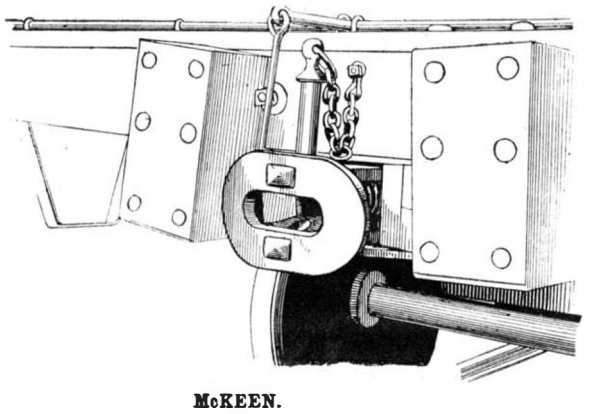
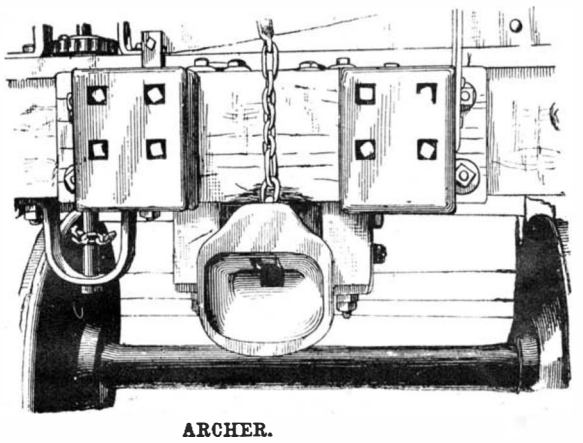
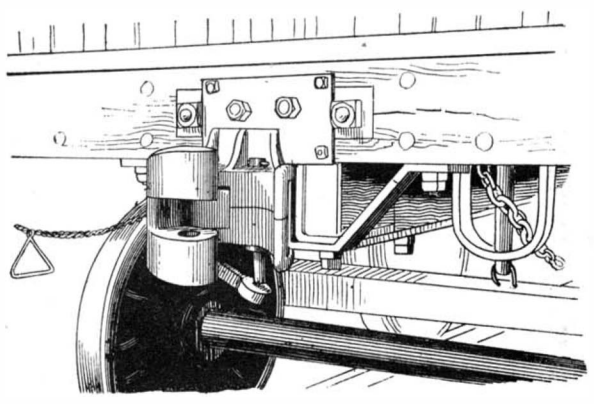


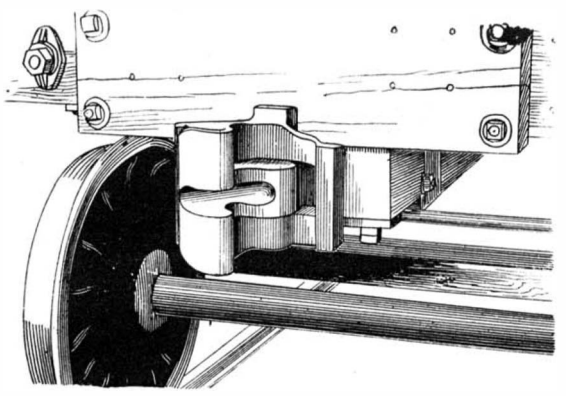
McKEEN.



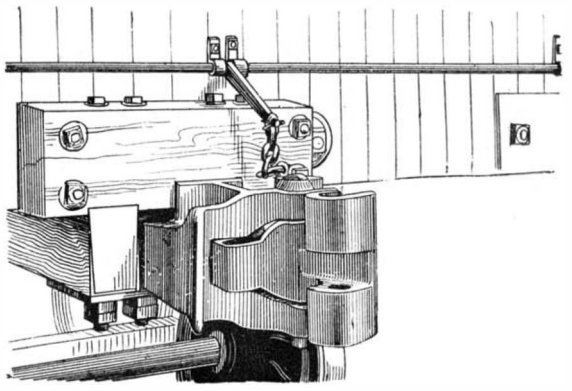
ARCHER.



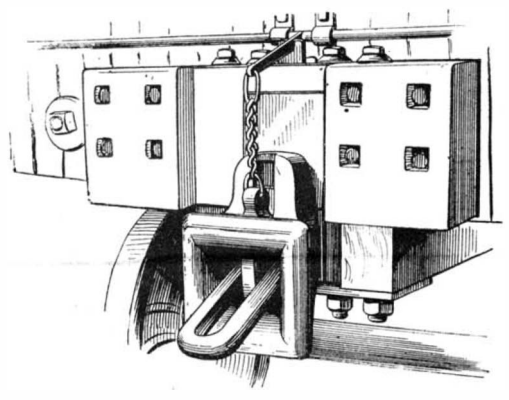
DOWLING.



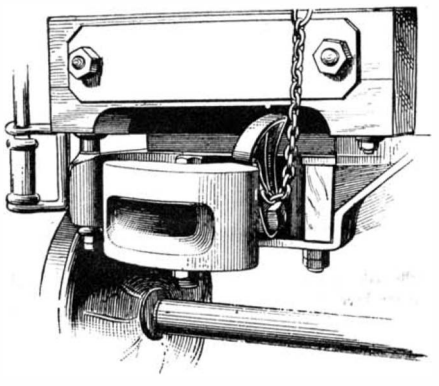
THURMOND.



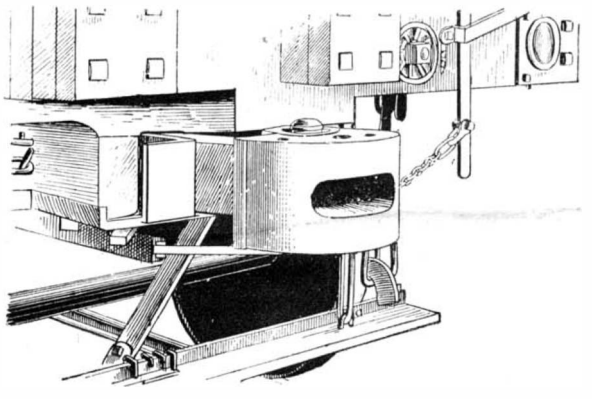
HIEN.



GIFFORD.



TITUS & BOSSINGER.



COWELL.

AUTOMATIC CAR COUPLERS ADOPTED AFTER TEST, AT BUFFALO, N. Y., SEPTEMBER, 1885.

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8. *Thurmond*, is also provided with a knuckle, which is locked by a piece sliding forward and downward. Operates by gravity, and is coupled with the old style by hand.

9. *Hien*, Chicago, is not unlike the Dowling, as it also has a knuckle opened by a spring and locked by a vertical piece. Its performance was not entirely satisfactory on a curve.

10. *Janney*, Pittsburg, has its knuckle locked by a vertical plunger actuated by a spring. Passed the tests very well.

11. *Cowell*, has a knuckle locked by gravity, and the drawbar guided by a "boot."

12. *Titus and Bossinger*, Huntington, W. Va., has its knuckle locked on the outside by a radial cam falling vertically. At lower speeds, coupled rather slowly.

It will be noticed that of the forty-two couplers submitted, but twelve were adopted by the committee.

Of these, six link couplers were selected, and six operating in the vertical plane, so that the relative merits of the two main classes may be expected to have a thorough practical test during the months which intervene before the next convention of the Association. It is very hard to obtain uniformity in any line, and in so vexed a question as that of car couplers, where there are about 3,500 patents already issued, we hardly expect to see the entire country settle down to the use of one or even a half a dozen of the prescribed forms. Nor does it seem to us desirable to thus crystallize an invention against further improvement. The necessary interchangeability can easily be obtained by constructing each automatic coupler to couple with the ordinary link, and consequently with its competitors. It is an easy condition to fulfill, and would leave greater independence to both railroad companies and manufacturers.

Natural History Notes.

Sense of Color in Animals.—J. Graber has investigated the sense of color and illumination in animals. To decide whether animals had a sense of color or of light, he placed them in a box so arranged that qualitative and quantitative rays fell on one or the other of its two divisions, which communicated with one another. Five mammals, seven birds, two reptiles, three amphibians, two fishes, three mollusca, twenty-seven insects, two spiders, and two worms were experimented with. It was found that the sense of color, as well as the power of perceiving light, was much more widely distributed among animals than has been generally supposed. The variations in the sense of color in various animals are very great, but a much greater number of observations must be made before a definite solution of the problem can be obtained.

Origin of the Lombardy Poplar.—According to Mr. Bossier, a botanist who has lately studied Oriental botany, this poplar is a distinct species, which he calls *Populus pyramidalis*. It is believed by the best authorities to have originated in Persia; some writers, on the other hand, state that it is truly indigenous to Italy; but the evidence, however, we think is strongest in favor of Persia, from whence most probably it was introduced into Italy, where it is now a favorite tree and extensively grown.—*The Garden.*

Colors of Birds' Eggs.—Dr. O. Laschenberg has recently published an abstract of his investigations on this subject in *Zoolog. Anzeig.* Some of his conclusions are the following: As has been stated by Krukenberg, the ground coloration originates in a different way from the spots and markings, though both are derived from the blood, and not from special pigment glands. The ground coloring is caused by a transudation through the uterus, which is richly supplied with blood vessels. The spots are formed by particles of pigment which are found throughout the oviduct, and probably arise in the Graafian follicle. The formation of the pigment is no doubt to be referred to a process similar to that which causes the corpus luteum in the ovary of mammals.

Immortality of Unicellular Organisms.—Professor A. Weismann (*Biolog. Centralblatt.*, iv., pp. 577–591, and 650–655) believes that the idea of a senescence of unicellular animals is not tenable.

Physiologically speaking, there is a profound difference between the uni- and multicellular organisms in the fact that the latter only wear themselves out by living, and proceed to a natural death. The unicellular animals are never so modified by the transformation of matter that life becomes impossible. They have no physiological death; their bodies are immortal.

Exhalation of Ozone by Plants.—Drs. J. M. Anders and G. B. M. Miller, who have been investigating the subject of the exhalation of ozone by odorous plants, sum up their conclusions in the September *Naturalist* as follows: (1) Flowering plants, including odorous and inodorous, generate ozone; the former, however, much more actively than the latter. (2) So far as tested, scented foliage does possess the power of producing ozone, and, in the case of pine or hemlock foliage, to a marked degree. (3) Inasmuch as no reactions occurred on rainy days, during the experiments, it is highly probable that the function demands the influence of the sun's rays, or at least of good diffused light.

Blind Fishes in California.—Mr. J. D. Caton writes to the *American Naturalist* that at Santa Clara College, in the San Jose valley, a 170 foot artesian well is flowing from which are discharged sightless fishes from one to two inches in length.

Influence of Heat and Light upon Vegetation.—*Ciel et Terre* gives the researches of Mr. Hellriegel upon this subject. This gentleman undertook in the first place to ascertain the lowest temperature at which seeds are capable of germinating, and confined his experiments to 18 species of cultivated plants. The seeds, sprinkled with distilled water, were planted in large receptacles filled with vegetable mould that were raised to constant temperatures of 48°, 40°, 38°, 35°, and 32°, and kept there for from 35 to 60 hours.

It was found that rye and winter wheat germinated at 32°. Barley and oats showed their cotyledon at 32°, but the root did not start till 35° were reached. Indian corn required 48°. The turnip germinated at 32°, flax at 35°, the pea and clover at 35°, the bean and lupin at 38°, asparagus at 35°, the carrot at 38°, and the beat at 40°.

The respiratory function requires little heat, and operates even in the entire absence of light. Heat and light, on the contrary, are most favorable for the assimilation of carbonic acid and its conversion into carbon. Mr. Hellriegel attaches very little importance to the color of the light.

Production of Male and Female Plants.—In some investigations made with a view to determining the conditions under which male or female individuals are produced in the case of dicœcious plants, Dr. Hoffmann has found that in most, if not all, the cases he examined, dense sowing increases the proportion of the male plants produced; and this results from an insufficient supply of nutriment. As a general law, the production of male plants is promoted by the want of an adequate supply of food when in an embryonal condition.

Use of Spines in Cactuses.—Our brethren across the water, assuming that thorns are simply for protection in a military sense, are exercising themselves in their serials over the spiny leaves of the holly. When young and vigorous, *i. e.*, in early life, the teeth are very spiny; when the tree is aged, and the branches then a distance above the surface of the ground, losing vigor, the spines are weak or absent. Sir John Lubbock and others, following the poet Southey, see in this a beautiful adaptation for protective purposes. When within the reach of animals, spines are borne; when high up where animals cannot reach, spines are unnecessary. Numbers of species of plants have mucronate points to the leafy serrature, which are wanting in maturer years. It is at any rate difficult to imagine why a sharp point should be made especially for protection, and points less sharp for no protective use at all.

I have often reflected on a fact referred to by Dr. Newberry, that our thorniest plants are in much greater proportion in places where animal life is scarce, and the immense police force sustained by the great vegetable community absolutely thrown away. Cactuses and other thorny things I have seen covered with thorns and spines on deserts where the hot air seemed to be bounding up and down like the surging ocean, and where not even a lizard could have dared to show its face. Thorns cannot be, so I have thought, for protection where the climate gives all the protection desired. I am not one who doubts that nature has a purpose in every move she makes, but the main purposes I think we seldom reach, and that we do ourselves an injury in research by assuming mere incidental uses as the main purposes for which structures seem to be "adapted."

One of these uses in the spines of cactus has occurred to me. They break the full force of the sun on the plant, a force it is made to endure and not to love, as we know who have learned to cultivate it. Plant lovers set out their treasures in summer under "arbors" of fish netting or galvanized wire, and those who have no experience would be surprised to find how the moving shadows of the twine or wire lower the temperature. A mass of spines on a cactus must certainly have the same effect. A cactus does not need much light on its epiderm to keep healthy. On the dry mesas along the Uncompahgre River I have seen some aggregated masses of *Echinocactus phœniceus* forming dense hemispheres a foot high and as much wide, with spines so thoroughly interlaced with spines as to rival the hedgehog, and leaving not a particle of the green surface visible; and there are species not cæspitose, such as *E. pectinatus*, which no one can see for spines without cutting apart, and forming a complete protection from the hot suns under which they are doomed to live.

I do not suppose I have yet reached the final purpose of spines in a cactus any more than we have the final purpose in the existence of the cactus itself, but that one use of cactus spines is to furnish a partial shade I feel to be beyond a doubt.—*Thomas Meehan in Bull. Torrey Botanical Club.*

How Flies Move upon Smooth Surfaces.—Some time ago Dr. J. E. Rombouts established the fact that flies attach themselves to smooth surfaces by the aid of a liquid secretion from the feet. This liquid, however, is not sticky, but the attachment is brought about by capillary attraction. Dr. Rombouts has recently strengthened his conclusions by an experiment which he describes in *Zoolog. Anzeig*, vii., pp. 619–623. Several flies were confined to a glass plate by strips of paper, and the liquid that accumulated was sufficient to be perceptible to the naked eye. By the aid of experiments with glass balls, it was found that the adhesive power of the liquid was less than that of water, and about equal to that of olive oil. Hence capillary attraction is obviously the only force that could bring about the required result.

A New Use for Eucalyptus Trees.—The patenting of a process for the manufacture of a preparation of the gum of *Eucalyptus globulus*, which has the effect of thoroughly removing the scales which form on steam engine boilers, and of preventing rust and pitting, has created a largely increased demand for it both in this country and in Europe. The effect of this preparation in preventing the pitting and corrosion of boilers will, it is expected, extend the period of their usefulness 100 or 150 per cent, and, at the same time, effect a great saving in fuel, as scale is a non-conductor of heat. The company owning the patent, at Piedmont (Cal.), has also embarked in the distillation of essential oils of the *Eucalyptus globulus*, which have heretofore been supplied by Australia, it being found that they can be produced at profit. With this object in view, the company proposes to set out extensive forests of *Eucalyptus* trees, in order to have at its command a sufficient supply of leaves, the portion of the tree consumed in the manufacture of the oils.

Deep Mining for Gold.

Although gold mining in Victoria, N. S. W., is an industry which is comparatively depressed just now, there are some features which are not only encouraging there, but also to gold miners in other parts of the world. The *Mining Registrar* for the central division of the Ballarat district reports the Band of Hope and Albion Consols Company, on the Redan line of reef, struck a solid body of stone two feet six inches in thickness in a cross cut at a depth of 1,000 feet, the greatest depth yet attained on that reef. "This opportune discovery of payable quartz at the deeper levels," writes the *Mining Registrar*, "cannot fail to give a great impetus to mining operations in this district and to this line in particular."

They believe in deep mining for gold in that region, as may be seen from the following list of the ten deepest shafts in Victoria: 1. Magdala Company, at Stawell, 2,409 feet. 2. Lansell's 180 mine, Sandhurst, 2,041 feet. 3. Victoria and Pandora Company, Sandhurst, 2,000 feet. 4. Newington Company, Pleasant Creek, 1,940 feet. 5. Prince Patrick Company, Pleasant Creek, 1,830 feet. 6. Crown Cross United Company, Pleasant Creek, 1,815 feet. 7. Prince Alfred Company, Pleasant Creek, 1,770 feet. 8. North Old Chum Company, Sandhurst, 1,684 feet. 9. Oriental Company, Pleasant Creek, 1,676 feet. 10. New Chum and Victoria Company, Sandhurst, 1,625 feet. Only two of these shafts were deepened during the quarter, viz., that of the Victoria and Pandora Company by 60 feet, and that of the North Old Chum Company by 20 feet.

The mining population of the colony is estimated by the *Mining Registrar* at 27,632. In quartz mining 12,409 miners are engaged, and 15,223 in alluvial mining. Of the total mining population 5,258 are Chinese. The value of the machinery employed in the gold fields is £1,879,316. The *Registrar's* reports show that in many localities mining suffered during the quarter through want of sufficient water for sluicing and crushing purposes. The total quantity of gold raised during the three months ended March 31 was 192,438 oz. 11 dwt. 15 gr., and its value at £4 per oz, is £769,754 6s. 6d. The area of auriferous ground actually worked upon is returned as 315 square miles, being about 4½ square miles in excess of the area worked upon during the previous quarter.

Mechanism of the Bee.

An investigator into the mysteries of animal life asserts that a bee's working tools comprise a variety equal to that of the average mechanic. He says that the feet of the common working bee exhibit the combination of a basket, a brush, and a pair of pincers. The brush, the hairs of which are arranged in symmetrical rows, is only to be seen with the microscope. With this brush of fairy delicacy the bee brushes its velvet robe to remove the pollen dust with which it becomes loaded while sucking up the nectar. Another article, hollowed like a spoon, receives all the gleanings which the insect carries to the hive. Finally, by opening them, one upon another, by means of a hinge, these two pieces become a pair of pincers, which render important service in the construction of the combs.

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ENGINEERING INVENTIONS.

A rail clearer for snow plows has been patented by Mr. Augustus F. Priest, of Fort William, Ont., Canada. The invention covers a special construction for track clearers and their attachment to the plow, whereby they may conform to the curves and irregularities of the track, and be lifted and let down at will by connections extending to the engine cab.

AGRICULTURAL INVENTIONS.

A harvester has been patented by Mr. William F. Weirick, of Charlestown, West Va. It has automatic rakes and binders, and is designed to be carried bodily upon and propelled by an engine, being arranged so that the engine driver may drop the bundles which have been cut and bound by the harvester.

A grain cleaner for thrashing machines has been patented by Mr. David L. Stroud, of Richford, Minn. To the sides of the sieve shoe are added extensions, with a series of rocker bars arranged between them on pivots, with fingers ranging from one to the other and overlapping them to form a riddle, the grain escaping from the straw and chaff as it passes over.

MISCELLANEOUS INVENTIONS.

A jar fastener has been patented by Mr. Charles Watts, of Crooksville, Ohio. Combined with a jar having apertures in its neck above the cover seat is a peculiarly bent wire locking device, intended to make a cheap and effective sealing attachment for earthenware jars.

A speculum has been patented by Mr. Joseph G. Ellis, of Oak Ridge, La. It is for the use of physicians and surgeons in making internal examinations, and the speculum is adapted to be withdrawn through the chamber of the instrument in connection with which it is used.

A gate has been patented by Mr. Samuel C. Gridley, of Nordhoff, Cal. This invention covers a special construction and arrangement of parts for a gate to move back and forth between two posts set at one side of the roadway, which will be strong and durable, and can be operated without stopping the team.

A breast pad has been patented by Mr. Charles L. Morehouse, of Brooklyn, N. Y. It is made of hollow rubber, to be suitably supported by straps and a belt, and, while being well calculated to fit the form, is susceptible of ready ornamentation with lace, ruffles, etc., while it may be covered with silk or other suitable material.

A treadle has been patented by Mr. Thomas P. Gooch, of Oakland, Miss. The treadle lever has its lower end formed with two arms, one having a hook and the other a foot piece, with other novel features, whereby the foot rest is intended to apply equally on both sides of the shaft, and so that friction will be in great part avoided.

A weighing scale has been patented by Mr. William Watkins, of Moss Point, Miss. It has two beams, one graduated to indicate values and the other prices at which articles are sold, the beams having weights which can be so adjusted as to enable the desired quantity of an article to be ascertained in pounds for a given price.

A brace wire fastening for wire fences has been patented by Mr. Arthur Lott, of Riddleville, Tex. Combined with the panel wires are braces and triarmed clasps embracing the wires and braces at their points of intersection, the clasps each being made in one piece, with its arms bent around a longitudinal or panel wire and a brace wire.

A hinge has been patented by Mr. John A. Resch, of Jersey City, N. J. The invention consists in hinges made with their plates of unequal width and bent outward or from each other at right angles, so that, when used for inside blinds, the latter, when folded together, can be turned back against the wall of the room at the sides of the window.

A ticket chart has been patented by Mr. Henry E. Lomas, of Cresco, Iowa. It consists in a printed plan, adaptable for any place of entertainment, with removable portions, so that these portions can be removed and attached to the tickets, and the remaining plan will represent the solid and unsold portions of the house.

A nut lock has been patented by Mr. Samuel J. Wisdom, of Montgomery, Ala. This invention consists in a washer having an inclined slot, and made with its top edge slightly bent, being especially designed for use with flanged fish plates, furnishing a cheap and reliable lock, with a washer that can be applied to the bolt without taking off the nut.

A screen attachment for bottling machines has been patented by Mr. Frank Seely, of New York city. It is made of sheet or cast metal, to be so attached to a bottling machine that the attendant will be fully protected against flying fragments of glass in case the bottle bursts when being corked, the screen being automatic in its action.

A safety check for music boxes has been patented by Mr. C. Henry Jacot, of Hoboken, N. J. Combined with the cylinder shaft is a ratchet wheel and a double pawl having a weighted arm, whereby the shaft will be stopped and held should its speed be unduly increased, thus preventing the pins and teeth of the comb from danger of being broken or injured.

A side bar vehicle has been patented by Mr. Luther Stouffer, of St. Joseph, Mo. Combined with a vehicle box and side bars is a spring rod or bar bent to form a square or oblong figure, with its outer ends crossed and extended laterally to the side bars, to which they are secured, giving a more gradual and easy movement than is usual in side bar vehicles.

A washing machine has been patented by Mr. Frank Beliel, of Hastings, Neb. It consists of a semicircular tub and cover hinged together, so made that the clothes are placed in a space between a board and cylindrical rubber, the revolving of the latter carrying the clothes around against the ribs of the board, springs pressing the board and rubber together.

A shears has been patented by Mr. Benjamin F. McCarty, of Rolling Prairie, Ind. The invention consists of a disk turned by a lever, a pivoted arm carrying dies and connected by arms to the disk, with an adjustable arm to prevent the metal from rising when being cut, the shears being especially devised for cutting metal bars and sheet metal by hand power.

A feeder for roller mills has been patented by Messrs. Louis Nolden and Alfred E. May, of Beardstown, Ill. It is made with a case having an inclined rear side, a skeleton, a rotary cylinder revolving within the case, and an adjustable feed plate to adapt it to feed middlings and other soft materials to the rollers regularly and uniformly.

An axle for vehicles has been patented by Mr. Governeur M. Forbes, of Salt Lake City, Utah Ter. It has crank arms at its ends, with cams for retaining the body level or nearly so as the crank turns over, the design being to make the vehicle travel more easily and smoothly than one with a straight axle over ordinary roads.

A grate for furnaces has been patented by Mr. Silas H. Huntington, of West Pittston, Pa. This invention covers a special construction of roller grate bars to provide a free air circulation through them to the fire, with hollow teeth alternating with the teeth of the grate bars, to prevent burning out, the formation of clinker, and secure a level settling of the fire as the bars are rotated.

A latch has been patented by Messrs. Rudolf E. Woodrich, of New York city, and Charles Langbien, of Brooklyn, N. Y. Combined with a lock casing is a sliding bolt therein, a knob shaft connected with the bolt, and a sliding latch in a sleeve surrounding the knob shaft, the bolt being acted upon by the knob shaft and also adapted to be locked in place by means of a latch.

An improved roofing has been patented by Mr. Benjamin B. Adams, of Roswell, New Mexico Ter. It consists of rectangular plates applied diagonally upon the roof by fitting the angle of each between the diagonal sides of adjacent plates of the course above, nailing the corner and folding the plate over to cover the nail, so the roofing will be unaffected by changes of temperature.

A composition of matter for lining or coating boxes has been patented by Mr. Adolf Hollner, of Dennison, Ohio. It is more particularly designed for boxes for holding coffee or other articles from which it is desirable to exclude moisture and preserve the aroma therein, and consists of glue, skimmed milk, and calcareous material, such as chalk, prepared and applied in a specified manner.

A mechanism for controlling steam driven sewing machines has been patented by Mr. James H. Rohme, of Newburg, N. Y. In combination with the drive pulley and a rock shaft a treadle is so arranged and connected that the pulley will be instantly stopped when thrown out of gear with its friction wheel, so that the machines can be instantly started or stopped, and their speed readily controlled.

A saw set has been patented by Mr. John S. Long, of Murphysborough, Ill. This is an improvement on a former patented invention of the same inventor, whereby the hammer is caused automatically to descend upon the anvil or saw teeth held thereon prior to delivering its blow, so as to indicate to the operator the exact position on the anvil that the saw tooth should be held to be effectively struck.

A job printer's case has been patented by Mr. George W. Butler, of Chicago, Ill. It consists of an upper and lower case made regulation size, the lower case having a large compartment in which to rest a "job galley," while on both sides thereof, and in the whole space of the upper case, are divisions for holding leads, rules, slugs, spaces, quads, and other conveniences for the work of a job printer.

A pendulum escapement for clocks has been patented by Mr. William Hart, of Kirksville, Mo. It is applied to the lower end of the pendulum, but detached from the latter, although the escapement wheel and lever may be fitted to operate at any point in the length of the pendulum, and the device is intended to facilitate the use of the pendulum by hanging shelves thereon for displaying goods.

An automatic cut-off for gas burners has been patented by Mr. John E. Birch, of Winnipeg, Manitoba, Canada. By this invention the expansibility of a confined body of air is utilized to hold open a valve that permits the flow of gas to continue, the air being heated by the normal heat of the burner, and so that when it cools by the extinguishment of the flame the valve will close.

A cartridge loader has been patented by Mr. Charles A. Thompson, of Hopkinsville, Ky. Combined with suitably held powder and shot holders is a shell carrying arm adapted to act on the stems of the holders, a rammer, a wad holder, and an ejector for forcing the wads out of the holder, with other novel features, adapted for a machine to be worked effectively by unskilled labor.

A fireproof floor has been patented by Mr. William W. Hazlett, of Toronto, Ohio. This invention relates especially to a protection for the lower portions of the flanged iron beams of the floors, and has for its object to improve the construction of the floors by providing a better protection to the beams, and also to facilitate the setting of the tile arches between the beams.

A stock car has been patented by Messrs. Daniel Lines and Charles T. Long, of Milano, Tex. It is so constructed that the hay racks swing up automatically and the troughs can be lowered to be out of the way when not in use, or easily swung up when the animals are to be watered, the design being such that ordinary cars can easily be converted in this way into stock cars.

A nut machine has been patented by Mr. Alfred Marland, of Pittsburg, Pa. Combined with forming and compressing dies are a cutting die at one side of the forming die, a blank cutting and carrying knife, and means for operating it for cutting the blanks and feeding them to the dies, with other novel features, the invention covering improvements on former patented inventions of the same inventor in nut machines.

A cotton press has been patented by Mr. Samuel I. Wilkinson, of Yazoo City, Miss. Combined with a box pivoted to swing in a horizontal plane are plungers connected with a fixed object, so the latter will be reciprocated in the box when the latter is swung or rocked, the press being one which can be operated by hand or power, and can be cheaply made of wood or metal.

A band pulley has been patented by Mr. Reuben Jones, of Atlanta, Ga. It is designed to carry a rope belt, and is a sectional pulley having teeth at its edges inclined in opposite directions, enabling both sections of the pulley to be cast in the same mould, forming a diagonal crimp in the rope between the teeth, and giving one sharp angle for the rope to catch against whether moving forward or backward.

A gate hanger has been patented by Mr. Issachar Crowfoot, of Hartford, Wis. Combined with the gate post is a screw held therein supporting a block or head in which the top supporting bar of the gate is held, so that by turning the screw the gate can be raised or lowered at will, the post passing through a spider frame, and its lower end resting in a flanged cup embedded in the ground.

An adding machine has been patented by Mr. John L. McCaleb, of Benton, Tex. It consists of a box with a spindle surrounded by a sleeve, there being a handle on the spindle and on the sleeve, with devices for turning the spindle from the sleeve, a cog wheel revolved from the spindle, and an extra hand in connection with the cog wheel, making a simple device for adding and multiplying numbers.

A ratchet drill has been patented by Mr. John J. Banta, of Pacific, Mo. There is a novel arrangement of pawls in a block fixed to the tool holding spindle, which is journaled in a frame or stock, the pawls being adapted to engage and slip over ratchet teeth fixed to bevel pinions loose on the spindle and driven by a gear wheel and crank, to insure the easier adjustment and more efficient operation of ratchet boring or drilling machines.

A method of making plush articles of clothing has been patented by Messrs. Charles Theinert and Simon Christiansen, of New York city. It consists of cutting the plush on the back by means of a knife diagonally to the warps and wefts, abutting the edges of the pieces, and uniting them by the glove or cross stitch, so that a garment thus made will have invisible seams, not indicated by any depression in the surface of the plush.

An odometer has been patented by Mr. Henry O. Brooks, of Lowell, Mass. The case has rings or hangers placed loosely on an elongated collar which is made in halves, and bound upon the axle so the collar revolves with the axle and the odometer hangs loosely from the collar, the split construction of the collar allowing it to be readily affixed to any axle, and the device being an inexpensive one for measuring the distance traveled by bicycles and other vehicles.

Business and Personal.

The charge for Insertion under this head is One Dollar a line for each insertion; about eight words to a line. Advertisements must be received at publication office as early as Thursday morning to appear in next issue.

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Notes & Queries

HINTS TO CORRESPONDENTS.

Names and Address must accompany all letters, or no attention will be paid thereto. This is for our information, and not for publication.

References to former articles or answers should give date of paper and page or number of question.

Inquiries not answered in reasonable time should be repeated; correspondents will bear in mind that some answers require not a little research, and, though we endeavor to reply to all, either by letter or in this department, each must take his turn.

Special Information requests on matters of personal rather than general interest, and requests for **Prompt Answers by Letter,** should be accompanied with remittance of $1 to $5, according to the subject, as we cannot be expected to perform such service without remuneration.

Scientific American Supplements referred to may be had at the office. Price 10 cents each.

Minerals sent for examination should be distinctly marked or labeled.

(1) R. H. K. asks (1) a recipe or method for rewhitening ivory, viz., handles on surgical instruments, etc. A. Treat with hydrogen peroxide. See SCIENTIFIC AMERICAN SUPPLEMENT, No. 339. 2. How may I toughen feet so as to take long tramps comfortably? A. Treating them with some astringent solution is said to be slightly beneficial. 3. Best black ink for pen sketches and other drawing purposes? A. You will find several formulas for inks given in SCIENTIFIC AMERICAN SUPPLEMENT, No. 157. 4. Which pencils do artists consider the best? A. Dixon's or Faber's; either are good. 5. Where can I get the best book or account of taking long tramps on foot? Practical papers. Also best one for sketching from nature? A. "A Pilgrimage to Canterbury," by the artist Joseph Pennell, may interest you. The files of 'Outing" are more likely to give you information of the character desired rather than any single book or books.

(2) M. D. asks: Would not the combustion of an old time blast furnace preclude there being a paying amount of iron remaining in the slag? Could graded iron be produced from this slag, using with it a fair percentage of scrap? Would charcoal fuel be of any advantage in such reduction? Please decide a discussion among your readers, in a general answer, including the chemical operations of such reduction and composition of product. A. The iron in the slag of old style furnaces is not worth the cost of redemption. It will not pay for the fuel for remelting.

(3) R. M. asks the most practical way to get rid of sewage, by absorption of the soil where the ground is level, and the frost line eight feet deep, the soil being compact clay. A. We know of no means of absorbing sewage in compact clay. You may so arrange a drainage system as to discharge on a lower level, and utilize the sewage as a fertilizer. Or, if a town house, gather in a cesspool and discharge by pumping into a wagon tank and hauling. This is much practiced in the Eastern States. In many places sanitary laws forbid absorption on account of well contamination.

(4) R. M. writes: Having dropped some indelible ink upon the oil cloth of the table of my

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study, I procured potassium cyanite to remove the same. But the solution being too strong, it left two large erasions, where the greenishness of the cloth is entirely taken away, or in some places but slightly. What should I use to restore the cloth to its former color? A. By the use of the cyanide you have entirely removed the color, and therefore it cannot be restored. A little coloring matter with some alcohol varnish might produce a new coating.

(5) L. P. S. asks how the cold rolled shafting is made. A. By pickling the round iron in an acid bath to free it from scale, and rolling between hard, polished, grooved rollers.

(6) S. A. H. asks how to clean a rubber watch chain that has become brown by or faded by the sun; it was originally black. A. Dip the chain in carbon disulphide. This chemical, however, must be very cautiously used, as it an exceedingly dangerous substance to handle by one not an expert.

(7) J. S. S. asks a rule for finding boiler capacity necessary for heating building where pipe and heaters are in place and radiating surface known? A. One square foot of effectual heating surface in boiler to eight square feet of radiating surface in cold or exposed buildings. One to nine and one to ten, where conditions are less active.

(8) E. E. D. asks when the Greek language ceased to be a living language. A. The so-called ancient forms never died out, but are nearly all found, even in the more cultivated modern Greek of the middle ages. Greek is now, says Geldart, "as really alive as it was in the days of Homer. Modern Greek resembles the ancient language fully as much as current English does the English of Chaucer."

(9) Hatmaker writes: We use a varnish to cover pin holes in cotton cloth and silk which leaves too great a gloss in contrast to the material (black); can you give us a recipe that would answer the purpose better? We use alcohol varnish only, and want a dead color? A. Try the following: Well wash 1 lb. of parchment shavings or cuttings in two or more lots of cold water; then put them into a saucepan or other vessel with 4 quarts of cold water, and let them simmer gently until the quantity is reduced to 2 quarts. Strain through a fine sieve, and one teacupful mixed with 1 quart of water are the proportions used in finishing silks.

(10) S. & F. ask how rubber bands are made. A. Rubber bands are made by cutting rubber tubing into suitable sizes. The process of making the tubing is given in SCIENTIFIC AMERICAN SUPPLEMENT, No. 251, under title of "The India Rubber and Gutta Percha Industries," a series of valuable papers appearing in SCIENTIFIC AMERICAN SUPPLEMENT, Nos. 249, 251, 252.

(11) C. S. asks: 1. In what proportion to take dextrine in place of gum arabic to have the same consistence and the same gloss, etc., as with the latter, for inks, varnishes, etc.? A. The gum is added for the purpose of holding the gallo-tannate precipitate in suspension, and also in order to give the ink a body or gloss on drying, therefore the amount is easily determined by adding the gum until the precipitate ceases to fall. The difference between the amount of dextrine to be used and the gum arabic will be very slight. 2. Receipts for burnishing ink for heel and sole edge polishing? A.

a. Extract of logwood.....1 to 2 ounces.
Tincture of iron.....1 to 2 "
Sweet oil.....1 to 2 drachms.
Diluted alcohol.....1 pint.

b. Extract of logwood.....4 ounces.
Bichromate of potassium.....12 grains.
Ferrocyanide of potassium.....12 "
Rain water.....1 gallon.

The ink in either case is applied with a brush and immediately burnished with a hot iron. 3. Some authorities on inks? SCIENTIFIC AMERICAN SUPPLEMENT, No. 157, treats the subject of inks quite fully. Spons' Workshop Receipts ($2) contain numerous recipes for the substances mentioned by you.

(12) H. C. asks: 1. What plating battery is the cheapest for gold plating jewelry? A. Better use a Smee battery. 2. Also, how to remove printer's ink from some valuable engravings without injuring them? A. It cannot be done except in places where a sharp eraser can be used.

(13) R. asks: Why does lightning so seldom strike trains and rails? Railroad men claim that the oiling and greasing of the iron is the cause. Mechanics claim it is the immense quantity of iron, that spreads and weakens the electricity. A. It is probably due to the diffusive effect of the metal of the track.

(14) C. T. writes: I have been building a battery of the cells and covered copper wire belonging to a telephone; the name on the cells is "Leclanche battery;" the wire is the wire which I found running in the walls of a building, and I also got an electric bell. I wound about 300 or 400 yards of the wire on a reel about 6 in. long; the reel is tin for the core and wood at the ends. I connected the wires from the reel to the electric bell, and connected the wires from the bell machine to the cells, two of them, then I connected two wires with handles to the electric bell machine. It will work all right, only when it has been working about ten minutes it gets weaker and again I have got the fine iron wires in the core, but it does not seem to regulate the current. Could you kindly help me out of my trouble, or tell me where the fault is? Is it with the wire all being of one size, or is it with the tin being in for the core? Can you tell me of any back number of the SCIENTIFIC AMERICAN SUPPLEMENT with the full description of building a battery, so I can get one? A. The trouble with your battery is that you keep it on a closed circuit too long. It is probably partially exhausted, and therefore polarizes or "runs down" quickly. The Leclanche battery is not adapted to continuous use, but is very efficient for intermittent use. The coil you have made, if we understand you, is only a primary or magnetic coil formed of office wire. You should have used magnet wire, and to secure the results you seek, you should apply a secondary wire. See article on induction coil in SUPPLEMENT, 160. For information on batteries consult SUPPLEMENT, Nos. 157, 158, and 159.

(15) J. L. B. asks whether a vessel with a centerboard can carry more sail without upsetting than one without, provided there is no weight to the centerboard? A. The tendency of a boat to capsize is increased by the centerboard (if light), by preventing the leeway of the boat on a side squall.

(16) J. B. H.—You could compress about 2,000 cubic feet of air into a steel cylinder 1 foot in diameter and 10 feet long. It would have a pressure of nearly 2,000 pounds to the square inch. A human being requires about 15 cubic feet of air per hour, so this would last three men 40 hours. It would run a 1 horse power engine about 1¼ hours, if the change of temperature caused by the use of the air were otherwise provided for.

(17) C. C. P. asks: When can a person be called a musician? Has a person got to know how to read music at sight before they can be called a musician, or is there such a thing as a natural musician? I had an argument with a lady here, and she claims that you cannot call a person a musician unless they can read music at sight, no matter how good they can play on different instruments. I claim if they are good players on different instruments, they are musicians. Which is right? A. A musician, according to Webster, is "one that sings or performs on instruments of music according to the rules of the art." One may be a good musician without being a *scientific* musician, and we would call any one who could produce good music a musician.

(18) C. R. C. writes: I intend to build a small steam engine, cylinder 2¼ x 1¼ in. About how many pounds power will it have? How large a boiler would it require, boiler made of ⅛ in. iron? How many pounds working pressure would it stand? How large a fly wheel would engine require? A. It would depend on the construction of the engine, the speed at which it is driven, and the steam pressure. Probably one-third horse power would be a fair estimate, the engine making 300 revolutions under 60 lb. average piston pressure. The boiler should have 4 to 5 square feet of heating surface. If you make the diameter of the boiler small, it will easily stand 75 lb. pressure per sq. in. Your fly wheel should be 10 in. in diameter, and should weigh about 20 lb.

(19) J. E. M. asks how much oxygen gas water will hold in solution, and the best simple means of generating it for office use? A. The coefficient of solubility of oxygen in water at 59° F. is 0·02989, *i. e.*, water will absorb 0·02989 of its volume of oxygen. This is a very small percentage. It may be greatly increased by lowering the temperature. For 32° F. the coefficient is 0·04114. Oxygenated water or peroxide of hydrogen, H_2O_2 is prepared by heating some baryta (BaO) in a current of oxygen, converting it into peroxide of barium (BaO_2). This is powdered, suspended in water, and acted upon by a stream of carbonic acid gas. The water is thus charged with peroxide of hydrogen: $BaO_2 + H_2O + CO_2 = BaO.CO_2 + H_2O_2$. The carbonate of baryta is allowed to subside, and the clear solution of peroxide of hydrogen is poured off. Oxygen is readily prepared by mixing with chlorate of potash one-fifth of its weight of powdered black oxide of manganese, and heating it in an iron or glass retort. The oxygen is conveyed from the retort to the wash bottle by means of a rubber tube. If pure oxygen is required it should be passed through tubes containing potash, to remove any carbonic acid and chlorine which it might contain. Two precautions are necessary in making oxygen; one is to test a small portion of the mixture of manganese and chlorate of potash in an open spoon or ladle over a flame, to see that it contains nothing which would render it explosive; the other is to remove the rubber tube from the retort when the bubbles of oxygen cease to rise in the wash bottle, to prevent the drawing of the water back into the retort.

(20) W. B. asks a good welding compound for cast steel. A. Borax 91 parts, sal ammoniac 9 parts. Pulverize together and melt in an iron pot until frothing ceases, pour out and cool. Then grind in a mortar to a powder for use.

(21) S. E. K. F.—Saw teeth should always be set so as to allow a clearance to the saw. It makes the saw run easier, and prevents heating by the friction. For circular and mill saws there are swedges made that set up the edge of the tooth to give clearance to the blade. The whole tooth does not need to be set out or swedged, only the point.

(22) Subscriber wishes a formula for making red, blue, and purple ink, used for rubber stamps. Also how to make a good hektograph. A. Red.—Dissolve ¼ ounce of carmine in 2 ounces of strong water of ammonia, and add 1 drachm of glycerine and ¾ ounce of dextrine. Blue.—Rub 1 ounce of Prussian blue with enough water to make a perfectly smooth paste; then add 1 ounce of dextrine, incorporate it well, and finally add sufficient water to bring it to the proper consistence. Violet.—Mix and dissolve 2 to 4 drachms aniline violet, 15 ounces alcohol, and 15 ounces glycerine. The solution is poured on the cushion and rubbed in with a brush. For hektograph, see SCIENTIFIC AMERICAN SUPPLEMENT, No. 438, under title of "How to Make and How to Use the Copying Pad."

(23) J. M. B. writes: We have made some "farm bells" out of cast iron, and they don't ring satisfactorily. What is the trouble? What composition should go in with the cast iron to make a good-sounding farm bell? A. Use hard iron, No. 4 or 5. Make the model from a good-sounding bell. The form has great influence on the tone.

(24) C. N. asks, in order to settle a dispute, the course a rifle ball takes after leaving the gun. A. The course of a rifle ball is very nearly a parabola, the curve or trajectory being the result of three forces—the impulse of the gun, the resistance of the atmosphere, and gravitation. You will find a very interesting and mathematical discussion of the whole subject of projectiles, illustrated with geometrical diagrams, in Chambers' "Treatise on Practical Mathematics," pages 348 to 353, which we can mail you for $1.50.

(25) E. W. asks: 1. How can cast iron plates one inch to one and one-half inches thick, eight inches wide, and five feet long, be chilled without springing the chills? The trouble we have met with is that the chill, which we make about four inches thick, expands on the top surface through contact with the hot iron, and throws the ends down, forming an arc of a circle, thus cutting the middle of the castings almost in two. We have also tried to chill these castings for about two feet in the center, and have failed on account of the chill warping and leaving an uneven surface at ends of chill. A. Either make your chill hollow and flow water through it, or make it sectional. 2. Also what is the best work you can name on electricity and electrical engineering? I want to make it a study; understand the elementary principles already. A. Dredge's Electric Illumination, Thompson's Dynamo Electric Machinery, Gordon's Electricity and Magnetism, Maxwell's Electricity and Magnetism. You should also study Faraday's Researches.

(26) G. K., Jr.—Paint sticks to tin that has been exposed to the weather for a short time better than to fresh, bright tin. There is a slight film of oxide formed by the exposure, which prevents the paint from chipping off.

(27) J. F. S. asks the best receipt for solution for the preservation of fruits in a fresh state for exhibition purposes. A. Glycerine has been recommended for the preservation of fruits, previous to eating which, the glycerine should be removed by immersing the fruit in water. Dipping the fruit in paraffine is an excellent means of preserving it. Collodion will probably be found most satisfactory for exhibition purposes. A thin coating of this varnish will entirely prevent the access of air to the fruit.

(28) C. M. asks the best way to mix plumbago and mineral oil, in order that the former may not precipitate, but remain suspended in the oil. A. The only way is to make the mixture so thick and pasty with plumbago that mechanical settlement is practically excluded.

(29) J. G. L. asks how to make a cheap orange stain for birch wood. A. Yellow or orange stains generally result from the use of nitric acid or turmeric. Thus 2·1 ounces finely powdered turmeric are digested for several days in 17·5 ounces 80 per cent alcohol, and then strained through a cloth. This solution is applied to the articles to be stained. Nitric acid diluted with 3 parts of water is likewise used. A hot concentrated solution of picric acid can likewise be used.

(30) G. A. F. asks what to apply to gilt gas fixtures to remove dirt, fly specks, etc. A. Very few chandeliers are gilt; they are burnished and lacquered with yellow lacquer. Take the chandeliers to pieces, and boil in strong soda ley for a few minutes, brush over with a soft brush, pass it through a strong solution of potassium cyanide (a deadly poison), wash through a tubful of boiling water, dry in clean saw dust, wipe up bright with a wash leather, and relacquer. A pale gold lacquer consists of 1 gallon of methylic alcohol, 10 ounces of seed lac bruised, and ½ an ounce of red sanders, dissolved and strained.

(31) C. R. S. asks how extract of malt is made, also quantity that would be a dose. A. Extract of malt is made from the infusion extracted with water at a temperature ranging between 160° and 170° Fah., drained off without pressure, and evaporated to the consistence of honey. It is nutritious and laxative. The dose is a tablespoonful or more, *ad libitum*.

(32) A. J. V. desires a recipe for mahogany stain. A. In order to produce a dark mahogany stain: Boil ½ pound of madder and 2 ounces of logwood in 1 gallon of water, and brush well over the wood while hot; when dry, go over the whole with pearl ash solution, 2 drachms to the quart. For a lighter stain: Put 2 ounces of dragon's blood, well bruised, into 1 quart of oil of turpentine; let the bottle stand in a warm place, shake frequently, and, when dissolved, steep the wood in the mixture.

(33) A. R. R.—For a silvering solution, add 15 drachms crystallized nitrate of silver to 250 drachms water, to which add 30 drachms cyanide of potassium; when dissolved, add 750 drachms of water in which 15 drachms of common salt has been dissolved. Clean the metal thoroughly and dip in a weak bath of nitric acid and water, rinse in clear water, and dip in the silver bath. The silvered wood mouldings are silver gilt or silver bronzed in the same manner as painters gild and bronze signs and ornamental work.

(34) W. J. L. desires (1) a remedy for removing rough skin from the face, that has been pitted by small pox. A. Use simple oil, pomade, or ointment medicated with croton oil, and of a strength just sufficient to raise a very slight pustular eruption, is probably the safest and most effective and convenient of all the preparations that are employed for the purpose of removing pock marks. 2. One for removing blackheads that appear on the face. A. Cover the parts affected with a pomade consisting of kaolin 4 parts, glycerine 3 parts, acetic acid 2 parts, with the addition of a small quantity of some ethereal oil.

(35) G. S. F. asks: Can a generator be made that will generate gas from 74° gasolene sufficient to supply 12 gas burners? If so, how can it be made and what size will it be, and what is the best kind of material to use to make same, and what shape would it be? A. It requires a great deal of experience to produce a generator for gasolene gas. Almost any device by which air is brought into contact with gasolene, or fibrous material saturated with gasolene, will produce gasolene gas, but the important points are to produce gas of uniform quality and to produce it safely. Our advice would be to purchase a machine from a reputable maker.

(36) P. H. B. asks: Is not a dose of aqua ammonia (diluted so much as not to be impossible to swallow, injurious to the taker, in some way, even while effecting some cure? If so, in what way? Are eruptions on the face and general loss of energy among the hurtful effects? A. Ammonia is simply a stimulant, and entirely transient in its action. It has no cumulative effect. Aqua ammonia is used chiefly as an external application; very seldom internally. If diluted with water to such a degree that it could be swallowed without difficulty, its effect would be slight, and there would be no reason to apprehend danger. Facial eruptions and loss of vital force and energy certainly are not to be charged to it: they are doubtless due to some other cause.

(37) R. M. G. writes: Will you kindly inform me how I can use the dynamo described in your paper as a motor and how many cells of battery I require to run it, and about what fraction of a horse power it will be? A. The dynamo will operate as a motor without any alteration, provided it is properly adjusted as a dynamo. Possibly you may be obliged to shift the commutator a little one way or the other. It will require from 8 to 10 cells of Bunsen or Grove battery to run it. It will not be as economical as if constructed for a motor. More wire on the armature and less on the field magnet would improve it for a motor. The amount of power realized from it depends upon so many circumstances as to make it difficult to say. Probably one-fifteenth horse power.

(38) J. W. C. asks: 1. Where can I get a two cell Leclanche battery? A. From any dealer in electrical supplies. Consult our advertising columns. 2. Can you give me any information in regard to making or wrapping an electro-magnet, and what size wire should I use on it? 2. For description of various forms of electro-magnets consult SUPPLEMENT, No. 182. The size of wire used will depend on the purpose for which you intend the magnet. 3. Where can I purchase electrical supplies? A. See our advertising columns. 4. Where can I get a book on electricity? A. See our book catalogue, which we send you. 5. Are there any directions in any back numbers of the SUPPLEMENT to make a battery and magnets? If so, what number? A. See SUPPLEMENT, Nos. 157, 158, and 159, for articles on batteries, and SUPPLEMENT, No. 182, for magnets.

COMMUNICATIONS RECEIVED.

"Why," by C. S.
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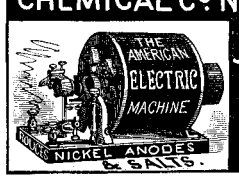

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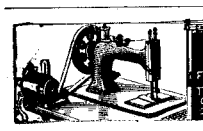

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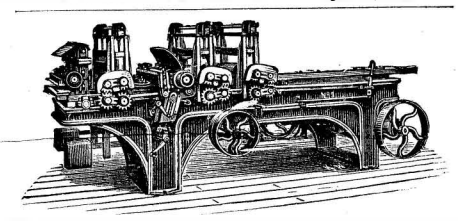

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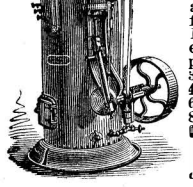

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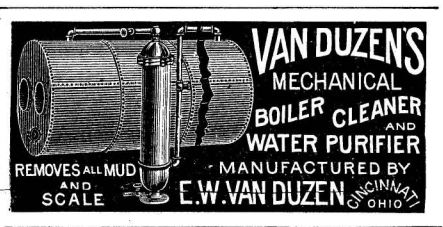

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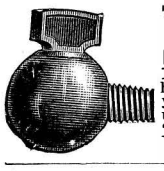

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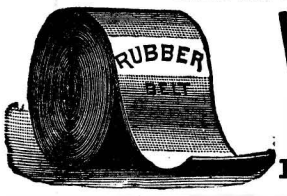

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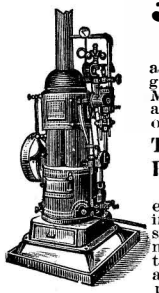

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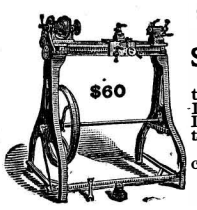

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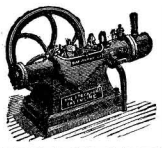

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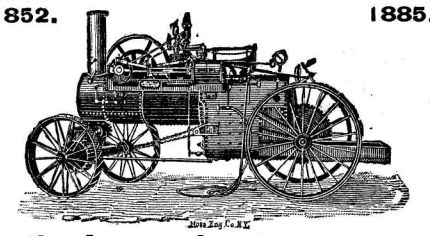

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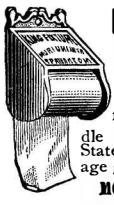

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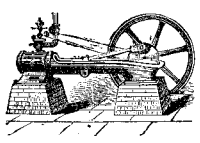

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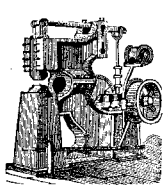

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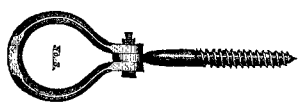

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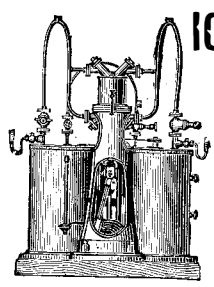

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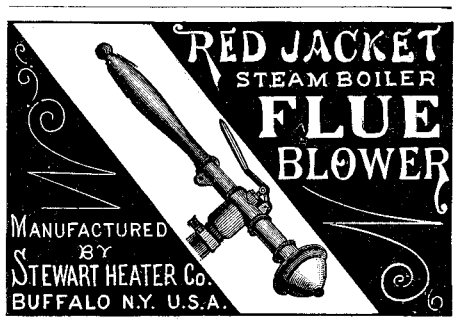

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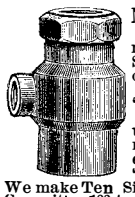

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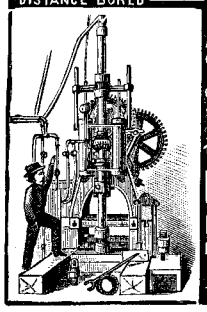

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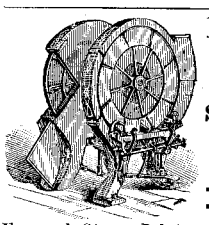

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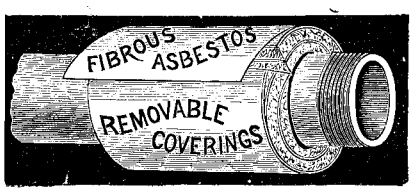

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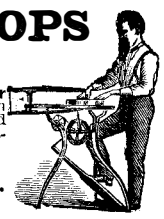

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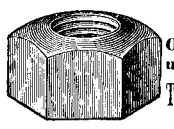

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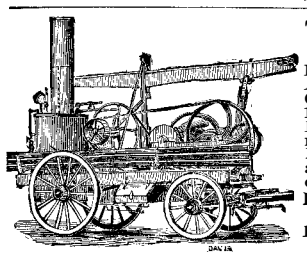

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